DOCUMENT RESUME

ED 097 213 SE 018 220

TITLE	Plants. Environmental Education Curriculum.
INSTITUTION	Topeka Public Schools, Kans.
SPONS AGENCY	Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
PUB DATE	May 74
NOTE	183p.; Best copy available; Occasional marginal legibility
EDRS PRICE	MF-$0.75 HC-$9.00 PLUS POSTAGE
DESCRIPTORS	Biological Sciences; *Botany; *Curriculum Guides; *Elementary School Science; *Environmental Education; Instruction; Instructional Materials; *Intermediate Grades; Natural Resources; Plant Growth; Plant Identification; Plant Science
IDENTIFIERS	Elementary Secondary Education Act Title III; ESEA Title III

ABSTRACT

The study of plants is often limited to studying plant structure with little emphasis on the vital role plants play in our natural system and the variety of ways man uses plants. This unit, designed for intermediate level elementary students, reviews basic plant structure, discusses roles of plants in nature's system, illustrates plant adaptations, discusses major plant biomes and examines ways man has utilized plants. Also presented are a variety of activities centered around myths and folklore about plants, poetry about plants and information on state flowers and trees. The unit culminates with a visit to a local conservatory. Suggested time lines, methodologies and evaluative instruments are included. (MLB)

environmental education curriculum

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ED 097213

ENVIRONMENTAL EDUCATION PROJECT
ESEA TITLE III, SECTION 306

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This rough draft was developed by the Environmental Education Project Staff, May 1974, for intermediate-level elementary school students.

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The work presented or reported herein was performed pursuant to a grant from the United States Office of Education. However, the opinions and material expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

PLANTS

Foreword

Our present day social structure tends to isolate people from daily contact with plants. This is unfortunate because people grow up without a real feel for the importance of and appreciation for plants.

Added to this the study of plants has often concentrated on plant parts with little emphasis on the fact that plants are a vital part of our natural system or dealt with the ways man uses plants.

The material in this unit briefly reviews basic plant structure, explores the various roles plants fill in the natural system, illustrates plant adaptations that match plants to their habitat; presents the major plant groups throughout the world, and examines ways man has utilized plants.

As part of this unit of study, students will visit the city conservatory to view sample plants from various parts of the world that do not live in the local climate. During this field trip students will direct special attention toward plant adaptations and man's use of plants.

To facilitate use of the material, objectives are listed in front of the unit followed by a cross-reference chart relating the objectives to appropriate unit activities.

Teachers are not expected to utilize all activities, but should select those appropriate for their students that will accomplish the unit objectives. Feel free to modify or substitute activities as necessary to obtain the best education possible. Diagrams, maps, poems, short stories, and other materials used in developing various activities are found in the appendixes.

Glenn Clarkson

Glenn Clarkson
Elementary Program Specialist

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ACKNOWLEDGMENT

The Environmental Education Project for the Topeka Public and Parochial Schools began operation June 29, 1971. The following individuals deserve recognition for the interest, time, and devotion they gave during the difficult stages of planning and writing the project proposal:

Mr. John Ganger, Coordinator of Curriculum for Special Education
Mr. W. I. Green, Director of Special Education
Dr. Quinton Groves, Director of Health, Physical Education, Safety and Athletics
Mr. Clarence "Tuffy" Kellogg, Assistant Director of Health, Physical Education, and Safety
Mr. Stanley Martin, Science Supervisor
Mr. Claude Ritchie, Principal, Gage Elementary School
Mr. William Wagaman, Principal, Avondale East Elementary School
Mr. Lawrence R. Gaston, Director of Federal Programs
Dr. Gilbert Wehmeier, Principal, Curtis Junior High School

The needed support given the project by Dr. Merle R. Bolton, Superintendent of Schools; other members of the central administrative staff; the instruction department; personnel office; business office; data processing department; maintenance department; and Lawrence Gaston, director of federal programs, is gratefully acknowledged.

Special recognition is given to the Board of Education for the Topeka Public Schools, who approved and are supporting this creative, exemplary, and innovative project.

My sincere gratitude is extended to the program specialists for their tireless efforts in developing this elementary unit. Curriculum development and revision has extended the working days for these staff members. My personal thanks are given to Glenn Clarkson, Bob King, and Thad Whiteaker for an outstanding job.

The enclosed curriculum is the result of input from the project's paraprofessionals and volunteers, fifth-grade teachers, Community Council members, parents, students, and interested lay citizens.

Bob Foster, city horticulturist, and his staff receive our special thanks for assisting in the collecting, developing, reviewing, and evaluating of materials, as well as assisting with field trips.

With the deepest appreciation, I acknowledge the work of the secretarial team. The constant revisions, pressures, deadlines, and demands for quality work were handled in a most outstanding manner by Dorothy Booher, Peggy Ketter, Rita Dreiling, and Marilyn Dorrell.

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UNIT GOALS AND OBJECTIVES

Goals:

1) To review the various plant parts and their basic functions.

2) To develop an understanding of plants' role in the natural ecological system.

3) To develop an awareness of how plants are specialized through adaptations to live in a particular habitat.

4) To develop an awareness of the major habitats (biomes) of the world and type of plant life found in each biome.

5) To develop an awareness of ways man uses and has used plants.

6) To explore people's feelings and attitudes toward plants.

7) To extend student's observational skills.

8) To provide an opportunity for viewing a variety of plants.

Cognitive Objectives:

Following the study of this unit, students will be able, on multiple-choice questions, to select a choice:

1) ...matching the various parts of "typical" plants with the major function of each part.

2) ...placing common representative plants correctly in any of the following groups: algae, moss, ferns, mold and fungi.

3) ...listing sunlight, carbon dioxide, water, and minerals, as basic needs of green plants.

4) ...indicating that one of the most important ways green plants help animals is by providing food.

5) ...indicating algae is the source of food for most water animals.

6) ...indicating mold and fungi are important in the natural system because they help recycle dead material.

7) ...indicating green plants consume carbon dioxide and release oxygen in the process of manufacturing food.

8) ...indicating that man's use of the land and its resources is the greatest factor in causing an increase in the number of endangered plants.

9) ...matching a general plant description with each of the following: major habitats, tropical rain forest, deciduous forest, coniferous forest, chaparral, grassland, tundra, and desert.

10) ...indicating that man uses plants for pleasure, food, source of chemicals, and building materials.

Cognitive Objectives (Continued)

11) ...recognizing common drugs, such as pencillin, can be extracted from a plant.

12) ...indicating plants can help control pollution by controlling erosion, absorbing noise, changing carbon dioxide to oxygen, collecting dust from the air, and screening unpleasant areas from view.

13) ...indicating man is now trying to extract insecticides from plants because they are likely to be safer than man-made insecticides.

14) ...matching flower structure with methods of pollination.

15) ...indicating very few plants contain substances that are dangerous to man.

16) ...matching plant with adaptative advantage.

Affective Goals:

Following the study of this unit, students will reflect a positive attitude toward the following concepts:

1) Having green plants around, helps improve the value of life.

2) All plants, even the ones considered poisonous, have some worth and value.

3) We need a variety of plants on the earth, not just those we consider valuable for food, lumber, etc.

4) City and national parks are valuable and should be used in such a way that people can enjoy them, but not destroy them.

5) People need to do more research into how plants are useful and affecting our lives.

6) Special efforts should be made to protect endangered plants.

7) Studying about plants is useful.

ACTIVITIES SUMMARY SHEET

Activity Number	Topic	Behavioral Objectives the Topic Helps Develop
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Activities Summary Sheet (Continued)

Activity Number	Topic	Behavioral Objectives the Topic Helps Develop
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6.5	Caring for Plants	Affective goals (variable)
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6.7	Fun Projects With Plants	Affective goals (variable)
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7.2	Trip Preparation	-----
7.3	Field Trip Leader Directions	-----
7.4	Field Trip Follow-up	(variable)

Suggested Time Line for Unit Activities

Day

Before the field trip:

X (A) Arrange the field trip date with the Environmental Education project staff as early as possible.

(B) Obtain approval of the field trip date from your building principal.

(C) Submit field trip request to your principal (See Appendix F).

(D) Contact the project office concerning the student pretest before teaching any of the unit.

(E) Arrange for the three slide sets from the Environmental Education project office after you determine the appropriate time for your classroom to view each set.

(F) Arrange with your media center to schedule the recommended films at the appropriate times.

X to 0 Teach the activities in Topics I through V, which you feel are useful, prior to having the field trip experience.

7 Prepare copies of the letter informing parents about the field trip (Samples in Appendix F).

6 Send parent letters home and invite the principal to participate in the field trip.

3 Make copies of the data sheet for students as directed in Appendix F.

1 Go over the data sheet with students. If signed parent permission is required, check to see all are returned.

Field Trip:

0 (A) Using masking tape, make name tags for each student, place on the upper left area of the student's chest.

(B) See that each student has a pencil or ball-point pen, and the data sheets.

(C) Have students use the restroom before leaving school.

(D) Have the students divided into 2 or 3 groups as agreed on with the Environmental Education project staff.

(E) Have students ready to leave at the agreed time.

Following the Field Trip:

-1 Discuss data sheets and field trip observations.

-1 to -X Teach any remaining activities that you feel are useful and will help meet the unit objectives.

-X Contact the project office to obtain posttesting materials and teacher feedback forms.

PLANTS

INTRODUCTION

The following questions are provided to help make the students aware of the type of material they will be studying in this unit. At this point do not take a lot of time discussing each question, but use the questions to find out what students are thinking regarding the concepts in each question. Explain that during the next few days they will be learning more about these questions.

1) How do plants affect our lives?

2) Where do plants live?

3) Why don't banana trees grow in Kansas?

4) How many different ways can plants reproduce?

5) Which is more important plants or animals?

6) What kind of plants do you like?

7) What kind of plants do you not like?

8) Should men be concerned about endangered plants?

9) How many different ways can you list showing how man uses plants?

10) How would our lives be different if there were no trees?

To help students become aware of the role and the importance of plants, three sets of slides have been developed to supplement the unit topics. After reviewing the content of these slide sets, teachers can select the most appropriate time to use each set in their classroom. The slide set titles are

(1) Introduction to Plants (an assortment of various tidbits regarding peoples views of plants, common plant groups, and unique comments about plants).
(2) Plant Adaptations (illustrations of how plants are suited to live in their environment).
(3) Some Ways Man Uses Plants (a collection of ways man depends on and uses plants).

The slide sets are available through the Environmental Education Project Office.

The narrations for these slide sets are included in Appendix A. The narrations as written are not intended to be read to students, but rather to serve as a guide from which the teacher conducts a class discussion. Utilize questions as much as possible to direct student thinking and observation.

1.0
Introduction

1.0
The plant structure and function activities presented in this topic are intended to serve as a review for the students. It is assumed that students in current or past science classes have studied plant groups, the major parts of plants, and the function of each part. Use the activities in this topic only if they will benefit your students. You may wish to do additional activities beyond the ones described in these activities.

Students can start a notebook during these review activities and continue it throughout the unit. The notebook could include sketches, diagrams, terms, pictures, news clippings, comments, and any other plant information of interest to the student.

1.1
Parts of a "typical" Plant

1.1
Place a house plant, preferably one with a flower, in front of the class or use the "typical" plant diagram in Appendix B. Have the students name each of the major parts and explain how the parts help the plant live. Students should have no trouble naming the following parts and describing the function of each.

(1) root - collects minerals and water from the soil, holds the plant upright, and stores food

(2) stem - provides a path for material to move between roots and leaves, serves as the "backbone" of the plant

(3) leaves - collect sunlight energy and gases from the air, and is where food is made from water, carbon dioxide, minerals, and the sun's energy.

(4) flowers - contain the parts necessary for producing seeds that can grow into new plants.

If students have difficulty listing and explaining any of the plant parts from above, it is suggested they do one or more of the following:

1.1
Parts of a "typical" Plant
(Continued)

A. Use reference books to learn more about the major plant parts. 3

B. Carefully examine the parts of a house plant such as the geranium. Cut the plant apart and study how the various parts are put together and how they help the whole plant.

C. Germinate some seeds and observe the various parts of the plant.

D. Observe VERY THIN - slices of various plant parts by using a microscope.

E. Place a healthy looking celery stalk in a colored water solution and observe what happens.

F. Cover one plant leaf with light tight material such as aluminum foil for two days and see how the leaf appears different from other leaves.

G. Grow some pea or bean plants and observe the flowers as they change.

1.2
Comparing woody and soft plants

1.2
Students should be able to list four or more ways woody plants differ from the soft plants found in our gardens, houses, fields, and pastures. To stimulate thinking have a bean plant (easily grown in the classroom from seed) and a small elm tree (from seed or dug from wooded area or along house flower bed, etc.). Ask questions similar to the following.

1) Which of these plants will die after producing seeds?

2) Which plant stem would you prefer to eat?

3) Do they both have the same basic parts?

4) Which will grow larger?

5) What happens to each one during the winter if they are outside?

6) How do their stems differ?

7) Can you think of any soft plant similar to the bean that does not die during the winter? (grass, tulips, iris)

1.2
Comaring woody and soft plants (Continued)

8) Which parts of the elm tree die during the winter?

9) Which kind of plant must produce seeds each year?

1.3
Observing Woody Plant Stems

1.3
After studying wood cross-sections students should be well aware that woody plants grow by adding new layers of material outside the heart wood and inside the bark. Students will also recognize the various layers typically found in wood cross-sections and be aware how layers vary among different types of woody plants.

Sets of wood cross-sections are available from the Environmental Education Project. Have the students work in groups where they can easily handle and observe one or more of the cross-sections. By using questions similar to the following the students can learn the various parts of a woody plant and how the parts serve the plant.

1) What causes the dark and light rings?

2) When are the light colored rings formed? Why?

3) When are the dark colored rings formed? Why?

4) From where does the tree get its material for growing during the winter?

5) Which is wider, the dark or light rings?

6) Are the rings completely round? What might cause some of the rings to be odd shapes?

7) Are there rings in the bark also?

8) Is the bark smooth on the outside?

9) Does the wood just inside the bark appear any different than the other wood?

10) Where is the oldest bark found? Outside or inside?

1.3
Observing Woody Plant Stems (Continued)

11) Where do you think new layers of heart wood and bark are formed?

12) How does the layer just inside the bark help the tree?

13) What does the heartwood do for the tree?

14) Are all the rings the same thickness? What might cause differences?

15) How is one tree cross-section different from another?

16) How old was the tree your cross-section is from when it was cut? How can you tell?

Students can sketch and label diagrams of cross-sections.

The diagram (Appendix B) of a tree cross-section with parts labeled and the function of each part explained can be used to reinforce the questions or as a review.

The wall chart "Growth of a Tree" and an accompanying teaching guide are available from the American Forest Institute. This chart is helpful in explaining how a woody plant grows.

To contrast the woody stems with soft plant stems have students bring in various soft plant stems and notice how they differ.

1.4
Observing Algae, Moss, and Ferns.

1.4
Many green plants that are living on the earth are neither woody nor fall into the typical group we call soft green plants. Students need to be aware of the less obvious plants such as the algae, moss, and ferns because they are an important part of our ecological system. If students are not already able to recognize examples of moss, ferns, or algae the following classroom exercises should help.

Algae samples can be found in any water that has been standing for a period of time or attached to rocks and sticks in the bottom of streams. The algae is green, slick

1.4
Observing Algae, Moss, and Ferns.
(Continued)

and slimy. Do not confuse algae with water moss. The algae does not have stems or leaves that are present on the moss. If you cannot collect algae from an aquarium or some other source, it can be raised in any jar of water. Just place some plant fertilizer in a jar of water and let it stand open in the light. In a week or so algae spores from the air will settle in the water and grow, turning the water green.

As the students view algae in a container ask them if they can see individual algae plants. They cannot because algae is a single celled microscopic plant. What they see is a group or clump of algae growing together. Use the micro-projector to view individual algae plants. Students can sketch the algae structure they see using the micro-projector. Appendix B contains diagrams of typical examples of algae that can be used for class discussion and illustrating various algae structure. Realize that this algae structure can only be seen by using a microscope or micro-projector.

The mosses are a slightly more complex plant than algae, but they are not as complex as the woody and typical plants. Moss plants do not have the special cells that help move water and material from one part of the plant to another. This lack of conductive tissue limits their size and ability to survive in areas where water is difficult to obtain. Material and water moves through the moss plants in much the same way water moves up a dish cloth when one end of the cloth is in a pan of water.

Samples of water moss can be obtained from aquarium supply stores. Water moss is the stuff that looks like green strings with leaves; sometimes it will have white root like attachments. Students that have aquariums can also bring samples of the water moss for observation. It should be possible to obtain four or five varieties of water moss to illustrate the variation within the group. Sometimes water moss can be collected from ponds, lakes, and streams.

Land moss can be collected in any area that is shaded and moist. This would include wooded areas, ditches along older roads, and shaded areas around buildings or other structures. Land mosses exist in several varieties, mainly differing in the shape and arrangement of the leaves. The samples of land moss that are collected for observation can be later used in building terrariums. The land moss will seldom be over three inches high and often it will be less than one inch. Sometimes the moss plant will have a capsule like structure on top. This capsule is the spore

1.4
Observing Algae, Moss, and Ferns (Continued)

case. The spore case contains spores or seed like structures from which new plants will grow. The moss plants never have flowers.

Allow students time to carefully observe and sketch the individual moss plants. Have the students discuss how the moss plants differ from the other plants observed.

Diagrams (Appendix B) of moss plants can be used for class discussion and illustrating various plant structures.

Fern plants are commonly used today as house plants, but are also found growing wild in some areas. For class observation the best source for ferns is a local florist or someone that has an extra fern plant. Some florists will provide classrooms with large fern branches such as those used in flower arrangements.

The ferns also exist in a great variety, but it is harder to obtain a variety of samples for classroom observation. The ferns are a more complex plant than the mosses, but still not as complicated as the typical flowering plants. Fern plants may have developing "fronds" that are rolled up and look like fiddleheads. Under some mature leaves may be found brown bumps or cases. These are spore cases, not a result of disease like some people think. The spore cases contain spores which are somewhat like seeds. When the spores are ripe the cases break open and the dust-like spores are spread over the ground and grow into new fern plants. Ferns, like mosses, do not produce flowers.

Allow the students sufficient time to observe and sketch the fern plants. The diagrams (Appendix B) of the fern plants can be used for class discussion and illustrating the various fern structures.

1.5
Observing Non-green Plants (mold and fungi)

1.5
The large group of plants called mold and fungi do not contain chlorophyll and are not capable of producing their own food. This lack of chlorophyll means the mold and fungi must obtain their food from other plants and animals. Often the mold and fungi will be living on dead material, decomposing it.

1.5
Oberving Non-green Plants (mold and fungi)
(Continued)

A variety of fungi and mold samples can be collected rather easily for classroom viewing. Some molds can be easily raised in the classroom.

Shelf or bracket fungi can be collected from dead logs and trees. It varies greatly in size and color, but it usually appears in a disk shape projecting from the side of a tree or log. Often the top will have concentric rings similar to the rings found in a tree cross-section. The shelf fungi is generally hard and woody like.

Toadstools or mushrooms (also forms of fungi) can most easily be collected in moist areas where there are dead leaves or grass covering the ground, especially on warm days following a rain. The mushrooms vary greatly in size, shape, and color.

Common bread mold can be easily grown in the classroom by placing a piece of damp bread (homemade is best) where mold spores from the air can settle on it. After being out two or three days the bread can be placed in a plastic bag to help keep it moist. In a week or less the black mold will be covering the bread.

Green mold can be found growing on citrus fruits such as oranges. This is often the common penicillin mold.

Other forms of mold can also be rather easily collected by students. As the students are observing the mold and fungi have them carefully smell and feel the samples. Be sure that the students wash their hands after touching the mold. Hand lens may help during the observing and sketching session.

The mold and fungi diagrams (Appendix B) will help in a class discussion of the fungi and mold's structure. Much of the detailed structure illustrated can only be observed using a microscope.

1.6
Lichens

1.6
Lichens fall into that category of plants that are around us everywhere, but seldom noticed. Lichens are unusual plants in that they are a combination of a fungi and an algae growing together as if they were one plant. Only by very careful observation with a microscope can you separate the algae and fungi. The algae in this partnership uses sunlight and makes the food for both, while the fungi acts like a sponge and provides the water.

1.6
Lichens
(Continued)

Lichens can be found growing on most trees' bark and on many older rocks. The lichens appear as thin blobs that vary in size and color. The color can range from yellows, blues, browns, greys, to greens. Students may see black cup shapes. The cups are spore cases. The sample lichen diagrams (Appendix B) will help in a class discussion of the lichen structures.

TOPIC II: ROLES OF PLANTS IN NATURE'S SYSTEM

2.0
Introduction

2.0
Each living organism plays some part in the large natural system that makes our earth what it is today. When man does not understand or ignores the part played by various organisms, he can cause great ecological damage to the system. Only through very careful modifications of the system based on knowledgeable understanding of its parts and their interaction will man be able to alter our environment without causing more damage than good. This topic will briefly look at various parts played by plants in the large natural system.

2.1
Basic Needs of Green Plants

2.1
By the end of this activity students should be able to list sunlight, water, carbon dioxide, and minerals as basic needs of all green plants and be able to determine how each is obtained.

Have any typical house plants in a location at the front of the room where all students can easily view them. Use questions such as the following to bring out the basic needs of green plants, and their sources. As students mention a basic need list it on the chalkboard.

1) Why does the flower pot have soil in it?

2) What needs to be added to the soil from time to time? Why?

3) Why is the plant green?

4) How does the green color help the plant?

5) Could it live without the green color?

6) What would happen if the plant was left in a dark room?

7) In which parts of a room do we usually keep our house plants? Why?

8) What do you think would happen to our plant if we placed an air tight jar over

2.1
Basic Needs of Green Plants (Continued)

it? Why? If the students say it needs air, ask if it uses only part of the air or all of it? If only part of the air, which part of the air?

9) Have you ever seen you mother add anything besides water to the soil in the flower pots? What was it? Why did she add it?

Other questions may also be needed or can be used in place of these. If students say plants get food from the soil, try to lead them into understanding the plants take minerals and water from the soil, carbon dioxide from the air, and energy from the sunlight and put these things together to make food. No organisms except green plants make their own food.

End this activity by having students sketch a simple plant. Use arrows to illustrate how the plant's basic needs enter the plant. Use labels to explain each arrow.

2.2
Plants as Food Producers

2.2
Without green plants, none of the other living organisms as we know them could exist on the earth. The food produced, through photosynthesis, by green plants either directly or indirectly is required by every other living organism.

Emphasize with the students that only green plants can carry on photosynthesis or make food. This can be accomplished by discussing the food chain diagrams (Appendix B). As the students view the food chains,use questions similar to these to emphasize that only the green plants produce food; all other organisms must eat.

1) Ask where or how each organism obtains its food.

2) What organism is at the beginning of each food chain?

3) Could the animals live without the plants?

4) Could the meat eaters live without green plants?

2.2
Plants as Food Producers (Continued)

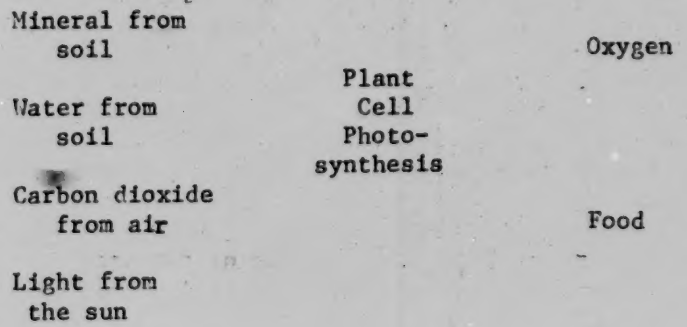
Any one of these films: "Green Plants Make Food", "Learning About Leaves", or "Plants Make Food" would be helpful in illustrating the process of photosynthesis or food making by green plants. Appendix A contains information and guide questions about these films.

End this activity by having students try to name some animal that does not get its food directly or indirectly from green plants.

2.3
Plants as a Source of Oxygen

2.3
Most students are aware their body needs oxygen and gives off carbon dioxide. After doing activity 2.1, students should have become aware that green plants use carbon dioxide. By the end of this activity, students should realize that green plants give off oxygen. Oxygen is a colorless and odorless gas. This makes it impossible for students to actually see oxygen. The releasing of oxygen from green plants can be demonstrated by discussing what happens inside green plant cells during photosynthesis.

After studying 2.1, students should realize that green plants use water, minerals, carbon dioxide, and sunlight. Explain that inside the cells these substances are combined together to make food which the plant stores. Another substance that results is oxygen. More oxygen is made than the plant can use so the extra oxygen is dumped into the surrounding air. About 80% of the world's oxygen is produced by the green plants (algae) in the oceans. Explain the process with a sketch similar to the following:



2.3
Plants as a Source of Oxygen (Continued)

Emphasize oxygen released from the green plants can be used by animals. The animals exhale the carbon dioxide which can be used by green plants. This pathway is known as the oxygen-carbon dioxide cycle.

2.4
Plants as Decomposers

2.4
In order for the natural system to continue to operate, material in plants and animals must be recycled when the organisms die. The nongreen plants, molds, fungi, and bacteria, are very important in this recycling process. These decomposers obtain their food from dead organisms. In the process of using the dead material for food they return the minerals to the soil. These minerals can then be reused by green plants. Other substances are released from the dead material as gases. Often these gases smell and produce the "stink" we associate with dead and rotting material.

Students can rather easily see the role of plant decomposers by watching mold grow over a sample of food such as cottage cheese or bread in a baby food jar. Leave the jar open and add water occasionally to keep the food moist.

TOPIC III: PLANT ADAPTATIONS

3.0
Introduction

3.0
Each species of living plant is able to reproduce where it is naturally found, because it has developed ways to obtain its basic needs and withstand competition. The structures and abilities that enable the species to survive are called adaptations.

Most plants cannot survive if their native environment is altered or they are removed from their native environment. They do not have the necessary adaptations to withstand the new conditions and obtain their basic needs in the new situation. This accounts for many people having difficulty growing house plants. Man can unintentionally destroy many plants by altering the plant's native environment, such as when grasslands are overgrazed by cattle and sheep.

This topic will only present a few samples of the ways plants have adapted to survive in their native habitat.

3.1
Plants and Seeds

3.1
Appendix B contains a page illustrating various ways plant seeds have become modified so they will be able to move to new locations before sprouting. As the students view these illustrations have them try to infer how the seeds are dispersed just by the seed appearance. Students can probably think of other ways seeds get scattered to new locations. A teacher's key for the seed illustrations is also included in Appendix B.

3.2
Ways Plants Adapt to Different Environments

3.2
Have the students view the plant adaptation illustrations, Appendix B. As the students view the plant diagrams have them try to describe the native environment of the plant. Determine an adaptation the plant has that helps it survive in its environment. A teacher key explaining the plant diagrams is also included in Appendix B.

3.3
Plant Adaptations for Survival

3.3
The short story "Plants Have A Few Tricks Too", Appendix D, points out a variety of plant adaptations that help the plants compete with other plants for basic needs

3.3
Plant Adaptations for Survival (Continued)

and assist the plants in protecting themselves from would be eaters. Questions at the end of the article will help bring out the variety of plant adaptations.

3.4
Animal Eating Plants

3.4
A few plants have special adaptations that allow them to digest small animals, such as insects. Most of these plants live where the soil is poor in nitrogen. Some scientists believe these plants obtain part of their nitrogen supply from the insects they digest.

The short article "Plants That Eat Animals", Appendix D, briefly describes some of the various adaptations the carnivorous plants have for capturing the insects. Some of the myths surrounding carnivorous plants are also discussed. The questions at the end of the article will help direct a follow up discussion.

3.5
How do New Plant Adaptations Develop?

3.5
Adaptations do not just occur because they help a plant or animal. Adaptations are the result of change in the heredity structure (mutations) of an organism. These changes can occur naturally or can be caused by man through the use of chemicals, radiation, and selective breeding. When a change in the heredity of a plant or animal occurs, the new offspring will be different in some way as compared to its parents. If this difference helps the new offspring compete with other plants or in some way gives it an advantage, the new offspring will live to reproduce. If it lives then the new adaptation will be passed on to its offspring and the new kind of plant will become common.

Most changes in the hereditary structure (mutations) do not help, but usually weaken the offspring. The offspring therefore dies and does not pass on the change.

The short article "When Plants 'Munch Metals'", Appendix D, does a good job of illustrating how natural mutations of plants can occur and survive. This article explains how, through new adaptations, plants are able to survive in soil ruined by mining, and how the same plant is handicapped when trying to compete in good soil. Questions at the end of the article will help direct a follow up discussion.

3.6
Endangered Plants

3.6
Large environmental changes cause the plants living in that environment to die. Over millions of years the earth's environment has been changing and many plants and animals that lived in the past are now extinct. Most of our environmental changes in the past have occurred slowly and new plants and animals developed as a result of mutations. Today man is causing rapid changes in the environment. These rapid changes do not always allow enough time for natural mutations to produce new varieties that can survive in the changed environment.

The short article "Yes - There Are Endangered Plants!", Appendix D, describes how man's activities have caused many plants to become endangered. Questions are provided at the end of the article to help direct class discussion.

3.7
Stories Illustrating Plant Adaptations

3.7
The following is a list of some of the short stories illustrating various ways adaptations have helped plants live in particular locations and ways.

(1) "The Amazon Jungle," Appendix D.
A description of how the jungle plants survive by having a close relationship between fungi and the larger plants. Discusses man's problems when he attempts to modify the land for farming.

(2) "Baobab - The Upside - Down 'Tree of Life'," Appendix D.
The Baobab tree is uniquely adapted to survive in the dry, bush - grassland of Africa and in turn is used by the area's animals as a source of food and water during harsh times.

(3) "Dutch Elm Disease - On The Scent Of A Cure", Appendix D.
Adaptations that involve the interrelationship between elm trees, beetles, and fungus and how man is using one of the adaptative behaviors of the beetle to help control Dutch Elm disease are discussed.

3.8
Using Knowledge About Plant Adaptations

3.8
As man becomes more knowledgable about the various adaptive characteristics of plants he can make decisions involving plants that will produce more satisfactory results. For example, man has developed numerous types of grasses for various environments. As the students view the lawn grass chart (Appendix E), have them select the grass type best suited for different conditions listed below.

1) A cool climate, shady and well drained soil

2) Moist region, full exposure to sun, fertile soil

3) Low temperatures, partially shaded, poor and wet soil

4) Cool, humid climate, shade, and acid soil

5) Dry climate, partially shaded, and clay like soil

6) Cool moist climate, fertile soil

Many types of lawn grasses, in addition to those found in Appendix E are available today. Several of the plants living today are the result of man's selecting and developing plants with specially desired characteristics. Wheat, corn, milo, and trees are examples. From these varieties man can select those that will grow and produce the best in a particular location.

TOPIC IV: PLANT GROUPS (BIOMES) FOUND IN THE WORLD.

4.0
Introduction

4.0
No two places in the world have exactly the same conditions: climate, temperature, seasons, rainfall, wind, and soils. Because of these differences the plant life will also vary from location to location. When one looks at the whole world, the plant growth can be placed into eight general categories or biomes. Of course, a great variety exists within the general categories.

By the end of this topic students should be able to name, describe, give a sample location and explain man's interrelationship with each of the eight general categories.

4.1
Locating the General Plant Types of the World

4.1
As students study the world map, Appendix B, have them indicate where the warm, cold, high rainfall, and low rainfall areas are located. These are the major factors that determine the type of plant life present in any given area.

Each of the general categories (biomes) has a name that is commonly used in communication. Some references use slightly different names and ways to identify each group, but all are very similar.

By reading the short description for each of the biomes students will gain a picture of the biomes present on the earth's surface. Short descriptions can be used for class reading, individual student reports to the class, or as guides for teacher-lead discussions. They are only intended to provide an overview of the biomes. Students can do additional research on each biome to supplement the short descriptions. Students may also wish to draw sketches of each biome based on the descriptions.

By the end of this exercise students should be able to complete the biome summary chart found in Appendix B. The chart will help guide classroom discussion and direct the students' attention toward the more important concepts to be gained from the descriptions. These major points are listed below:

A. Coniferous forest

Major points to bring out:

4.1
Locating the General Plant Types of the World
(Continued)

(1) cone-bearing evergreen trees are the dominant trees

(2) coniferous forests often exist where other trees cannot due to their adaptation to withstand rough weather conditions and poor soil.

(3) coniferous forests cover most of Canada, some of the New England area, and parts of Alaska

(4) short summer growing seasons and long cold winter

(5) includes the redwoods of the Pacific coast

(6) some of the evergreens need fire before seeds germinate

(7) coniferous forests provide us with our lumber and pulp for paper

B. Deciduous forest

Major points to bring out:

(1) characterized by most of the trees losing their leaves during the winter season

(2) deciduous forests are composed of several layers of growth

(3) common in Eastern United States, Great Britain, Central Europe, and Asia

(4) the seasons vary from long, warm days to short, cold days

(5) source of hardwood lumber used in furniture

C. Tropical Rain Forest

Major points to bring out:

(1) characterized by thick tall trees and nearly bare ground

4.1
Locating the General Plant Types of the World
(Continued)

(2) located along the equator

(3) high rainfall and little seasonal variation

(4) very little sunlight reaches the ground

(5) movies often misrepresent the tropical rain forest

(6) not good for farming

(7) tropical rain forest not real important area for lumber or other forest products

D. Chaparral Forest

Major points to bring out:

(1) chaparral characterized by short, tough, bushy-like trees

(2) found in Southern California

(3) two seasons instead of four, never gets really cold

(4) semiarid climate

(5) plants do most growing during winter season

(6) the native chaparral is being replaced by housing, industry, and agriculture

(7) in the past the chaparral served as a grazing area, source of medicine, tools, and food for the native Indians.

E. Grassland

Major points to bring out:

4.1
Locating the General Plant Types of the World
(Continued)

(1) native grasslands are composed of a mixture of grass and other small plants

(2) grass cannot easily compete with trees

(3) most of the native grassland has been replaced by domestic grasses - corn, wheat, oats, etc.

(4) most rainfall occurs during spring

(5) grassland originally covered most of central United States

(6) wind and water erosion often occured when the native grass was removed

F. Tundra

Major points to bring out:

(1) surrounds the northern polar ice cap

(2) summer days are long and cool, while winter days are short and cold

(3) soil is frozen solid during the winter

(4) tundra is a swamp-like place during the short summer

(5) all tundra plants are small and fast growing

(6) used to graze reindeer and other animals

G. Deserts

Major points to bring out:

(1) deserts are located on every continent and in areas where dry winds blow over the land. Example: Southwest portion of the United States

4.1
Locating the General Plant Types of the World (Continued)

(2) have little rainfall, high daytime temperature, low nighttime temperature

(3) little moisture in the air allows great temperature variations

(4) plants are usually relatively small, tough, able to withstand temperature variations, grow rapidly in short rainy periods

(5) soil usually rich in minerals

(6) plants adapted to either store or collect water during dry periods

(7) most animals are nocturnal due to hot daytime temperature

H. Plant life in the water

Major points to bring out:

(1) three-fourths of the earth's surface is covered by water

(2) algae is the most important water plant

(3) most plant life in water is near the shorelines

(4) man has polluted much of the ocean shorelines

(5) life in the ocean holds potential as a source of human food

4.2
Building a Terrarium

4.2
Constructing, maintaining, and observing a simple terrarium in the classroom will help students understand different biomes and some of the problems in operating a greenhouse or conservatory. A simple, easy-to-maintain terrarium can be constructed using a widemouthed gallon or quart jar.

If an empty aquarium is available it can be used. With the jar on its side, place approximately 2 inches of soil inside the jar. Moisten the soil just slightly. Either sow seeds of small plants or place <u>small</u> plants such as moss

4.2
Building a
Terrarium
(Continued)

on the soil. Close the lid and place the terrarium in the room so it will receive light, but will not be in direct sunlight. Terrariums of this type can be made by either individual students or by small groups.

As the class is observing the terrarium, discuss the basic needs of plants and how these basic needs are met inside the jar. There will be worms, bugs, and microscopic organisma in the soil to produce the carbon dioxide needed by the plants.

Do not remove the lid unless excess moisture collects on the inner surface of the jar. If the terrarium is too damp, mold and fungus will take over. There should be slight condensation on the inner surface when the jar is cool.

Terrariums can be made to represent different environments by changing the type of plants and conditions. A tip sheet on building various types of terrariums can be obtained from the County Extension Office.

4.3
Observing micro biomes
or local habitats

4.3
Although students cannot take field trips to visit each of the major biomes found in the world, they can visit local parks and other areas that have varied habitats. These habitat visitations may provide the students with a better understanding of how the local biome varies. Various habitats can be used to illustrate the general characteristics of most major biomes. When using a local habitat to illustrate a major biome, be careful that students realize that the plants, climate, and animals in the biome are only vague representations of large biomes.

Following are helpful points in relating biomes to local habitats.

Coniferous forest - Samples of pine trees can be found in some city parks. Have the students note the pine needles and cones under the trees. A good example is in Gage Park just south of the conservatory.

Deciduous trees - Samples can be found in most parks and along stream banks. The best in-city grove is in Dornwood Park. Bring out the variety of hardwood trees and the layers of growth.

4.3
Observing micro biomes or local habitats (Continued)

Tropical Rain Forest - This can be illustrated by visiting the city conservatory. No local habitat reflects this biome.

Chaparral Forest - The chaparral is somewhat like the thick bushy growth found between a grassland and a woodland along stream banks.

Grassland - The grassland being the primary biome of Kansas can be illustrated with any unmowed grass area. Most city parks have an area of this type. Burnett's Mound is one area that still has the native grasses.

Tundra - Tundra would be somewhat like the mossy areas found under deciduous trees in damp areas. Of course the tundra would be much colder and have a variety of small plants.

Deserts - No local habitat is a good representation of a desert. Areas like some playgrounds, roadside dirt roads, and old abandoned gravel or rock quarries can be used to illustrate how plants space themselves similar to desert plants.

Plant life in water - Any local pond or stream found in many of the city parks contains representative plant life. Classroom aquariums can do a reasonable job of illustrating life in water.

TOPIC V: WAYS MAN USES PLANTS

5.0
Introduction

5.0
The number of ways man depends on plants is endless. In this topic, we will explore a few examples of how man uses plants and provide suggestions for additional exploration. One way to introduce students to this topic would be to have the students compile a list of ways man uses plants. The list might include these categories: food, medicine, wood, rubber, many chemicals, cooking oil, textiles, penicillium, starch, dyes, narcotics, and pleasure.

5.1
Producing more plant food for man

5.1
The article "The Green Revolution", Appendix D, illustrates how man is trying to modify plants to produce more food. The processes of plant research and hybridization are the same type activities that have produced our relatively abundant supply of food crops. The article brings out some of the problems that are created when outsiders try to assist other countries. One of the important facts that can be brought out with the article is how the man developed plants are less well adapted to compete with the natural competitors like insects, fungi, and weather. Some other topics relative to plants and man's food supply that students could use as library research projects could include producing hybrid corns - contact one of the seed companies for literature about this, use of soybeans, making hominy, making flour, spices (nutmeg, anise, ginger, cloves, and cinnamon), olives, coffee raising and processing, cocoa, raising algae for food, organic methods of gardening, organic methods of farming, composting, backyard gardening, gardening farms, use of radiation to produce new kinds of plants

5.2
Plants help control Man-made Pollution

5.2
The short article "Plants Help Control Pollution," Appendix D, illustrates some of the ways man can use plants to help control noise, odors, and dust. This is a relatively new area, but is quickly gaining the attention of architects who draw plans for cities and highways. Even though pollution control by use of plants is considered a new science,many people have planted shrubs and other plants along roadways to reduce dust and noise. The diagrams illustrating ways to reduce noise by using plants, Appendix B, will reinforce the article.

5.2
Plants help control Man-made Pollution (Continued)

Questions at the end of the article will help direct student discussion.

Students can follow up this article by contacting the local highway commission and their architects to see if they are using plants to help reduce pollution or if they are just using the plants for aesthetic reasons.

5.3
Ways Man Uses Trees.

5.3
Most people think of lumber when they hear the word tree. Of course lumber is an important product from trees, but we also get many other chemicals and useful materials from trees, but we also get many other chemicals and useful materials from trees. An awareness of the variety of products obtained from trees can be obtained by using the wall charts "What We Get From Trees," that is available from the Superintendent of Documents, for 20 cents.

This poster can probably be most effectively used by posting it where students can view it at their leisure. This will give the students time to read and think about the vast amount of information presented.

Students can expand the information on the poster by doing research into how various products are extracted or made from trees.

One topic that could prove to be a very interesting research project for a student would be to find out how the cedars of Lebanon were used and what happened to the area where the cedars grew.

5.4
Special Tree Related Industries in Kansas

5.4
Kansas is not often thought of as a forest state, but a variety of industries in Kansas do depend on our state forests. These forest related industries promote interesting research projects for students. By doing research projects students develop a better understanding of Kansas economy and develop pride in our state. The third issue of Kansas Magazine, 1971,(a copy should be available through libraries) is completely devoted to the forestry industry of our state. The Cooperative Extension Service, Kansas State University, has publications available describing the forestry industry in Kansas.

Kansas forestry related industry worthy of special projects are

1) charcoal briquette production at Chetopa, Kansas

5.4
Special Tree Related Industries in Kansas (Continued)

2) Christmas tree farms at several locations in Kansas

3) Walnut gunstock production in Kansas City, Kansas

4) Pecan production in southeast Kansas

5) Using trees for windbreaks and shelter belts

6) Developing wildlife habitat through project SASNAK under the direction of the State Forestry, Fish, and Game Commission

5.5
Aesthetic Use of Plants

5.5
Man has long looked upon plants as a source of pleasure and beauty. He uses plants to decorate the inside of his home, beautify his yard, wear as ornaments, and as recreational areas.

The short articles "Parks Versus People" and "The Battle Over Wilderness", Appendix D, points out how people trying to enjoy and partake of the beauty of plants are literally destroying what they are trying to enjoy.

The students should be able to develop an excellent discussion on the value of aesthetics. The questions at the end of the articles are intended to help develop this type of discussion.

Other aesthetic uses man makes of plants can be researched by the students. Examples of topics that can be researched are

1) house plants and which part of the house they can live in

2) production of hybrid roses

3) contact local architects about how plants are used for aesthetic development around buildings

4) find examples in home magazines of how plants are used in and around homes to make the home more pleasant to live in

5.5
Aesthetic Use
of Plants
(Continued)

5) obtain from a local nursery brochures and booklets illustrating the kinds of plants available for home improvement

6) contact our state Forestry, Fish and Game Commission about how they are developing state parks

5.6
Plants as a Source
of Chemicals

5.6
Chemicals extracted from plants have been very important to man throughout history. Many of the early medicines used by man were chemicals from plants. Early man did not have a name for the chemical or plant extract, but used it by drying and crushing the plant or boiling the plant in water. Today we know which chemicals in the plants produce the desired results and many times can produce the chemicals in laboratories cheaper than they can be extracted from plants.

Some other chemicals that can be extracted from plants include penicillin, heroin, sugar, opium, perfumes, poisons, and spices.

The article "Garlic - Herb that Kills Insects," Appendix D, can be used to illustrate the value of chemicals found in plants. The article also compares the environmental affects of a natural plant chemical with man-made chemicals. Also included is excellent information on how man extracts and studies the chemicals found in plants.

Questions at the end of the article will provide assistance in discussing the article.

The article "Say It With Flowers - Pyrethrums!" found in the December 1973 issue of the American Forests Magazine, is similar to the Garlic Article. The pyrethrum flowers have been used as an insecticide by the Chinese for over 2,000 years. Due to its effectiveness and safety, growing pyrethrum flowers is becoming an international business. This article brings out relationships between nations, economics, history, research, and pollution problems. This article would make an excellent special project for some student to read and report on to the class.

5.6
Plants as a Source of Chemicals (Continued)

Appendix E contains a list of common plants and the ways the plants were used by the Indians. This information can be used to spark some student interest in doing additional research.

Other possible topics relating to chemicals from plants that students can research include

1) The production of penicillin

2) opium and heroin

3) use of natural insecticides in organic gardening

4) companion planting in gardens

5) sugar production and processing

6) natural dyes

7) natural perfumes from plants

8) poisons from plants

9) use of plants by the Indians

10) folk medicine

5.7
Plants help Control Erosion

5.7
Life on land depends directly on the quality of the soil. When the soil is damaged it is no longer able to support as much life. Erosion from wind and water are the principle forces that can ruin soil. Nature, as long as man does not interfere, protects the soil by covering it with plants that slow the forces of wind and water. Man is just starting to understand how to use plants to protect the soil he has disturbed.

The film "Dust Bowl" does an excellent job of illustrating the results of removing the natural plant cover. The film is available from our media film

5.7
Plants help
Control Erosion
(Continued)

library and also from the Topeka Public Library. The film is old and in black and white, but does a good job demonstrating the relationship among man's usage of land, value of plant cover, and the dust bowl days. Appendix A contains questions that will help direct a classroom discussion following the viewing of the film.

Following are a few examples of activities that will help students become more aware of the role of plants in controlling erosion.

1) contact the local extension service office for information on contour farming, strip cropping, use of water ways, terracing, and other soil conservation practices.

2) set up a demonstration using two trays of soil to illustrate how plants help prevent soil erosion. One tray contains bare soil and the second contains soil with plants growing in it. Set the trays on a slant and sprinkle water over each tray. Compare the amount of soil eroded out of each tray.

3) Visit and record areas around your neighborhood where plants are helping control soil erosion or where plants could help stop erosion that is now occurring.

4) do research on how and why the deserts of the world are getting larger

TOPIC VI: ODDS AND ENDS ABOUT PLANTS

6.0 Introduction	6.0 There are important and interesting facts about plants that have not been covered in the other parts of this unit. A few of these odds and ends will be presented in this topic.
6.1 State Flowers and Trees	6.1 A flower and tree have been selected as symbols by each state. A list of the flower and tree of each state is listed in Appendix E. Students may wish to select one or more of the plants and do a short report on it. They could also develop an interesting bulletin board displaying pictures of all state flowers and trees. Another interesting challenge for the students would be to find out why there are state flowers and trees and the process each state went through in choosing a flower and tree for its state.
6.2 Biblical Plants	6.2 Studying the plants mentioned in the Bible provides some insight into the way the land appeared in Biblical times and other ways man has used plants. The article "Plants From The Land of Milk and Honey," Appendix D, will serve as a starting point in the study of Biblical plants.
6.3 Christmas Plants	6.3 Many plants have become associated with Christmas. The article "Plants of The Holiday Seasons," Appendix D, gives a short description and informative comments about many of our plants associated with the Christmas season. This article could serve as the basis for some very interesting student constructed displays around Christmas time.
6.4 Plant Myths	6.4 Through history man has worshipped many idols, including plants. Some of the rituals are still continued today without any real knowledge of their origin. Several reasons now exist to explain man's ritual of kissing under the mistletoe during Christmas. The article, "A Story of Tears and Kisses," Appendix D, presents one of the versions explaining one use of mistletoe.

6.4
Plant Myths
(Continued)

After hearing this legend students may wish to research for legends to help explain some of our other rituals.

6.5
Caring for Plants

6.5
As our population becomes more and more urban people wish to raise and protect plants around their homes. Many of the plants we use for home beautification are not in their native environment and therefore require special care. The article "First Aid For Sick Trees," Appendix D, can be used to create student interest in caring for plants. Local nurseries and county extension offices are excellent sources for additional information along this line.

6.6
Plants As a Host
for Animals

6.6
Many kinds of plants provide homes for animals. There is a special relationship between many insects and plants resulting in growths called galls. Galls are enlarged areas of plants normally resulting from insects laying their eggs in the plant tissue.

The article "Plant Galls: Host and Parasites," Appendix D, can be used for starting an interesting project in studying plant galls.

6.7
Fun Projects
With Plants

6.7
Plants and parts of plants can be used to make various articles. By doing activities involving plants students can develop greater appreciation for plants, become curious about plants, realize how plants affect their lives, and see how plants can bring satisfaction to them.

Appendix E contains simple directions for several individual and group activities that students can do.

6.8
Poetry About Plants

6.8
Poetry is one avenue by which some people can express their feeling about plants. Others can enjoy plants through reading poetry. Appendix G contains a few samples of poetry about plants. Students can illustrate and interpret this poetry as well as write some of their own.

6.9
Poisonous Plants

6.9
Some people are almost afraid to visit a wooded area due to fear of being poisoned by some plants. There are plants that can cause illness or even death, but these plants are very few and can normally be avoided with a little effort. Most cases of poisoning by plants result from eating plant parts. Parts of some of our common plants such as potatoes, rhubarb, and onions are considered poisonous if not properly prepared.

One should not eat potato sprouts or potato skin where the sun has caused the skin to turn green because these parts contain a poisonous chemical called solanine.

Eating very large amounts of onions over a long period of time can cause anemia or other types of illness. Eating large quantities of spinach will produce a calcium deficiency. Even the seeds of the common apple contain a chemical that is poisonous if eaten in large quantity.

A very good reference on poisonous parts of common plants is the paperback book, Deadly Harvest, by John Kingsbury, Holt, Rinehard and Winston, 1965.

Students should not be fearful of plants because they could be poisonous. Far more people are injured and killed each year by cars than by plants. A few simple rules will usually prevent poisoning from plants. Students should become aware of these rules -

1) a person should only eat plants or parts of plants they or someone they trust know to be safe

2) learn to recognize plants like poison ivy and avoid touching or crushing its leaves

3) if you are alergic to certain plants, learn how to avoid those plants

4) if you want to eat wild plants, be sure you can distinguish between the edible varieties and the poisonous ones

TOPIC VII: FIELD TRIP AND DIRECTLY RELATED ACTIVITIES

7.0
Introduction

7.0
The field trip will provide an opportunity for students to view plants representing several of the concepts presented in this unit. Many of the plants observed during the trip to the city conservatory are not native to this area. The activities in this unit are intended to prepare students and teachers so they will be able to gain the maximum from the field trip. Before leaving the school teachers and students should be aware of the objectives, type of activities and how the activities will be conducted during the field trip.

7.1
Operation of a Greenhouse

7.1
During the field trip students will have an opportunity to observe a greenhouse. Before the field trip, discuss with the class the purpose of greenhouses.

Discuss the following points:

1) a greenhouse enables man to create an appropriate environment for plants enabling us to raise plants from habitats other than our own.

2) the temperature, relative humidity, and lighting can be controlled inside greenhouses.

3) greenhouses can be heated by steam, electricity or gas during cold weather. When using direct gas heating special care must be used to prevent air pollution.

4) much of the heating in a greenhouse is from the sun. The sun's rays are changed to heat inside the greenhouse.

5) review the basic needs of plants - light, water, minerals, and carbon dioxide.

7.2
Trip Preparation

7.2
In addition to completing the teacher-chosen activities in the first five topics, additional pre-field trip planning is necessary. Teachers need to fill out a field trip request form (sample included in Appendix F) and submit it to the

7.2
Trip Preparation
(Continued)

building principal. Parents need to be notified about the trip. Parent signatures may be required by the principal before the students can participate in the field trip (sample parent letters are included in Appendix F.) Arrange the field trip date, leaders, and transportation well in advance.

Each student will need (1) one copy of the field trip data sheet, Appendix E, (2) pencil or pen and, (3) a clipboard or notebook.

7.3
Field Trip Leader
Directions.

7.3
The field trip leaders need to be aware of the unit goals, objectives, and purposes of the field trip. In addition, Appendix F contains on-site leader directions to assist the leaders in conducting the trips inside the conservatory. If all leaders will be aware of and follow these directions, the students will have an excellent educational experience and groups will not be interferring with others.

Each leader should have no more than ten students. This will allow greater student-leader interaction and better student observation of the plants being viewed.

7.4
Field Trip Follow-up

7.4
After the students return to the classroom, they should be allowed to discuss and exchange trip observations. Relate the field trip observations to the various activities that have been previously discussed. The teacher field trip discussion guide (Appendix F) will assist in directing the follow-up discussion. You may wish to do some of the unit activities previously omitted.

APPENDIX A

FILMS AND SLIDE SET NARRATIONS

Films

The Dust Bowl. A-2

Green Plants and Sunlight. A-3

Learning About Leaves. A-4

Plants Make Food. A-5

Slide Set Narrations

Introduction to Plants A-6

Plant Adaptations. A-9

Some Ways Man Uses Plants. A-13

THE DUST BOWL

26 min. - black and white - McGraw Hill

This film dramatically illustrates the result of people using the land to fulfill their greed and ignoring the natural relationships that exist. Whenever people exploit the natural world in conflict with the natural balances and relationships, the exploitation will ruin the area involved. The Dust Bowl illustrates this relationship and how man learned from the experience. The film is old but has excellent content. Do not overlook the social impact resulting from a poor understanding and use of the environment.

Relate the causes of the dust bowl to our present day use of our environment.

Questions for discussion:

1) What areas were involved in the dust bowl?

2) What kind of crops were planted by the first farmers to settle in the central plains states?

3) What factors caused the rapid rate of increase in farming prior to the dust bowl?

4) What was the condition of the land in the early twenties?

5) What conditions changed that first brought on the dust bowl?

6) How long did the drought last?

7) What factors contributed to the dust bowl?

8) What was the relationship between the depression and the dust bowl?

9) What was a duster?

10) What would happen when a duster moved in during the day?

11) What effect did the dust storms have on transportation?

12) What happen to the crops that were planted during the dust bowl days?

13) Why did many people have to sell their livestock?

14) How did people react during the dust storms?

15) What were the Okies?

16) What book was written about the blown out farmers moving to California?

17) What did the government do following the dust bowl years?

18) Why was the dust bowl called a blessing in disguise by some?

19) How long after the dust bowl years was it before the land started producing crops again?

20) Why do many say another dust bowl will never happen?

21) Do you feel another dust bowl can never accur? Why?

GREEN PLANTS AND SUNLIGHT

11 min. - color - EBE Corp.

This film does an excellent job of illustrating the process by which food is manufactured within green plants. A series of experiments are illustrated, some of which could be performed in a classrcom. As with most films, you will need to emphasize the point that only green plants, not animals, have the ability to manufacture food.

New words and words for discussion:

photosynthesis	Chlorophyll
stomates	sugar
starch	oxygen

Suggested questions for discussion:

1) What type, or group, of plants produce most of the food within the oceans?

2) How deep does sunlight penetrate the ocean surface?

3) Where does the energy stored in food come from?

4) What material is made by green leaves when exposed to sunlight?

5) Why was starch found only in green leaves?

6) What does a green plant need to make food?

7) Which is made first, sugar or starch?

8) Where does the oxygen go that is produced?

9) Can green plants grow without sunlight?

10) Where does the carbon dioxide used by the plants come from?

11) Where does most of the food production occur, in the ocean or on land?

12) Why were the leaves placed in hot water?

13) What affect did the alcohol have on the leaves?

14) When iodine turns material dark, what does this indicate is present?

LEARNING ABOUT LEAVES

16 min. - color - EBF Corp.

This film shows several experiments related to food production within the leaves. Some of these experiments could be performed in the classroom. The film does a fairly good job of explaining the materials needed for food manufacturing and how these materials are used by the plants.

You will need to emphasize that only green plants are capable of capturing the sun's energy and making food. If you repeat the experiment using alcohol, do not get alcohol near an open flame.

New words and words for discussion:

chlorophyll	food
time lapse photography	leaf scars
starch	energy

Suggested questions for discussion:

1) In what part of the plant is sugar formed?

2) What materials are used by plants in making food?

3) Why do they take the chlorophyll out before testing for starch?

4) Finding starch in a leaf proves what?

5) Why do plants that live more than one year store food in their roots?

6) Why is food stored in seeds?

7) Do all plants make food?

8) Does the shape of a leaf affect its ability to make food?

9) Will plants grow in the dark?

10) Can all colors of light be used by plants to make food? How could this be tested?

11) Could animal life exist without green plants?

12) What should we do with leaves when they fall from trees?

Suggested follow-up activities:

1) Make a classroom leaf collection. Caution the students about collecting too many leaves from one tree!

2) Compare several leaves from one tree. Are they all the same shape and size?

3) Use iodine to test various foods for starch.

4) List some plant roots we eat.

5) Grow one plant in the light while a like plant is grown in the dark.

6) Collect some twigs and view them for leaf scars.

PLANTS MAKE FOOD

11 min. - color - Churchill

Uses animation in portions of the film to help illustrate how plants make food. Very basic, but well explained for an introduction. You will need to emphasize only green plants are capable of producing food and that all animals depend on the green plants for food. Contains some experiments that can be performed in the classroom.

New words and words for discussion:

Carbon dioxide	root hairs
chlorophyll	starch
minerals	weeds

Suggested questions for discussion:

1) How do minerals get into the plants?

2) What function do the root hairs perform?

3) What function does the stem perform for a plant?

4) Do all leaves have the same vein patterns?

5) In what form is food stored by plants?

6) Are weeds important food producers?

7) Diagram a plant and label what each part does in the production of food.

8) Can leaves make food at night?

9) What are some of the consumers shown in the film?

INTRODUCTION TO PLANTS - SLIDE SET NARRATIONS

This slide series is an assortment of various tidbits regarding peoples' views of plants, common plant groups, and unique comments about plants. The intent of this series is to create student interest in studying more about plants. This slide set is not a "typical" survey of the plants.

1) Wild meadow flower

Plants are different things to different people. Some people see beauty in these wild flowers, some see these plants only as weeds, some are reminded of wide open grassland, and others think of the role these plants play in nature's system of living organisms. The variety of visions and memories stimulated by plants are as great as the people doing the viewing. So plants are many things to people.

2) Fall leaves

As you are viewing the slides in this series, think about the variety of plants in the world and their influence on our lives. What does this picture of golden tree leaves make you think of?

3) Roosting birds

Plants are a very important part of nature's system. How is the plant in this picture being used?

4) Tree - fall view

When people communicate with others it helps if they can use words that both parties understand. With the next few slides we will illustrate some common words used to describe groups of plants. When discussing plants we normally talk about groups such as trees, grasses and so on rather then talk about individual plants. This is just like using group terms like men, women, children, etc. instead of individual names. What are some groups this belongs to? Here are some examples: deciduous tree, woody plant, ornamental plant, shade tree, and maple.

5) Fern

What common group does this plant belong to? Fern.

6) Lichen on rock

Can any of you think of the group these flat plants growing on a rock represent? Lichens.

7) Barrel cactus

What group do you usually place this plant in? Cactus.

8) Succulent

Is this a cactus? No, a succulent. This succulent often lives in the same areas with cactus, but is not called a cactus because of slightly different structure. Notice there is no fine hairy like sticker around the larger thorns.

Introduction to Plants - Slide Set Narrations (Continued)

9) Natural assortment of plants

Nature seldom has only one kind of plant growing in any area. How many different kinds of plants do you see in the slide that includes about a square foot of area?

10) Evergreen cones

Many evergreens have separate male and female cones. On this type, the male cones are the small brown ones and they only last for a few weeks during the spring. The green ones are young female cones and the brown cones are mature female cones that have opened to release their seeds.

11) Leaf galls

Many insects lay their eggs in plant leaves and stems. The plants will often produce a growth over the eggs, such as has happened on these hackberry leaves. The growths vary greatly in size, shape, and kind of plants involved. These growths are commonly called insect galls.

12) Elkhorn plant

Sometimes the heredity of plants changes suddenly. We call these changes mutations. This is a normal elkhorn plant. Compare this with the next slide which is a deformed or mutated elkhorn plant.

13) The deformed elkhorn

Compare this with the previous elkhorn plant.

14) Mulberry leaves

Sometines there is a lot of variation in the shape of leaves on the same plant as shown by these three mulberry leaves from the same tree. Notice the difference in the shape of each of these three leaves.

15) Century plant

The common names of plants originate from many sources. This century plant got its name from the fact that people used to believe it took the plant 100 years of growing before it produced a flower.

16) Man-eating plant

The man-eating plant got its name from movie making people. Human bones were found under these large tropic philodendron plants by early scientists and explorers. The explorers did not do any research on why the bones happened to be there and just assumed the plants had caught the people and sucked their blood out. This story was picked up by the movie makers and used in jungle movies. Later is was determined the people had died as a result of wars in the area. These plants in no way eat man or other animals.

17) Oleanders

The oleander, which lives in areas such as the southern states, is one of the most poisonous plants in the United States. People unaware of the poison in the oleander will use it for wiener sticks. The sap from the stick will get into the wiener and cause the wiener eater to get very sick or die.

Introduction to Plants - Slide Set Narrations (Continued)

18) Burned over forest

Natural activities such as lightning as well as man's activities can cause large areas of plant life to be destroyed, as is demonstrated by this area where a forest fire has burned. Many years will be required for this forest to recover.

19) City conservatory

Topeka, like most larger cities, raises plants especially for esthetic use in their parks and public buildings. On your field trip, as part of this unit of study, you will visit the Topeka conservatory where many of the flowers used in our city parks are started. Also, the conservatory contains an assortment of other plants from throughout the world which people can enjoy during visiting hours.

20) Cutting bed

One of the ways used in the conservatory to increase the number of plants is through cutting. Small branches of the plants will be cut from the mature plants and placed into this tray of perlite. A fine spray of water is regularly released over the tray. In a few weeks the cutting will develop roots and can be planted in pots.

21) Bedding plants

This is an example of the bedding plants that are being prepared for planting in the various city park flower beds.

22) Grass in rain

As you see plants, stop and think about the many ways the plant affects your life.

PLANT ADAPTATIONS - SLIDE SET NARRATION

The intent of this slide series is to illustrate and increase student awareness of how plants live in environments for which they are suited. The type of adaptations that suit a particular plant to its environment varies from the obvious, like thorns, to the very subtle such as influence of day length.

1) Hills and valley growth patterns

This and the next few slides will give you a brief glimpse of the natural growth patterns of plants. In this slide notice that the plants growing on the hill tops are different than the plants growing in the ravines or valleys. What do you think causes this kind of pattern? What time of year was this picture taken?

2) Flint Hill Valley view

Carefully view this slide and compare the growth pattern with the pattern in the last slide. How is it different? Do you realize the green area in the bottom of the valley is a farmer's crop? Why is this area used by the farmer for crops? What do you think this area was like before farmers moved into it?

3) Mountain side

How many types of plant growth do you see in this picture? How do they change from top to bottom? Could this slide have been taken in Kansas?

4) Alpine Valley

Compare the changes in plant growth from the top to the bottom in this picture. As these few slides illustrate, the type of plants found in any area depends on conditions in the specific area in which they live.

5) Alpine Tundra

In order for plants to survive in any area they must be able to live and reproduce in conditions that exist. The plants in this slide are able to live and reproduce in mountain top areas. They are able to grow and reproduce in a very short growing season. Few of these plants are over four inches tall. The plants in the tundra areas around the arctic circles are similar to these.

6) Tree lichens

Plants such as these lichens growing on the side of a tree are unusual in that they are really two plants growing together as if there were one. The lichen consist of algae and fungi. The algae is able to manufacture food and the fungi acts as sponge collecting and storing water for the algae. The algae and fungi each help the other and are therefore able to live in locations where neither one could exist by itself.

7) Rock lichens

Several other kinds of lichens are able to survive on rocks. How many different types of lichens can you see in this picture? These lichens are part of nature's system for turning rocks into soil.

Plant Adaptations - Slide Set Narrations (Continued)

8) Dodder

The orange stringy looking vines are an unusual plant called dodder. The dodder plant is a parasite. By this we mean the dodder plant takes its food from other living plants. Instead of having its roots in soil like most plants, its roots go into green plants and rob them of their food.

9) Spanish moss

The clumps of stuff hanging from the tree is Spanish moss. Spanish moss is different from our typical plants in that its roots are collecting minerals and water from the surrounding air. It is not a parasite like the dodder plant. In what part of the country would you expect to find the Spanish moss growing? State flower of Oklahoma.

10) Orchids

There are a great variety of orchids, some of which are shown here. Most orchids are adapted to live hanging from trees, rocks, or other structures above the ground. If their roots are covered with soil, the roots rot and the plant dies.

11) Ferns

Ferns, such as the ones shown here growing in the Olympia Forest, are adapted to live in moist humid areas.

12) Sage brush

In areas where there is a limited supply of water available to plants, the plants have adaptated various ways that help them survive. One way plants adapt to these conditions is by spreading apart allowing greater space from which each plant can collect water. This is illustrated here by sage brush.

13) Desert plants

Other desert plants, like these, partially solve the water shortage by having very small leaves or no leaves at all. These small leaves help by reducing the amount of water lost through the plant leaves.

14) Barrel cactus

In some plants, like this barrel cactus, the leaves are so greatly changed they do not manufacture food, but serve as the protective devices we call thorns, needles, or stickers. The food manufacturing in this type of plant occurs in the stem which is usually enlarged and green.

15) Old man cactus

This old man cactus can get sunburned just like some people. To prevent the sunburn, the old man cactus grows the hairy like covering that helps shade the cactus plant covering.

Plant Adaptations - Slide Set Narrations (Continued)

16) Morning-glory

All green plants must reach sunlight in order to live. Some plants have strong stems to reach upward while others like this morning-glory have the ability to climb on other objects.

17) Upside-down carrot plant

The upside-down carrot plant is adapted to live in areas where the annual rainfall is less then two inches. Under just right conditions this plant will produce leaves and grow for short periods. If it gets too much water it will rot and die.

18) Barrel cactus

Like many cactus, this barrel cactus has the ability to collect water during rain storms. The cactus will swell up when the water is available and then shrink during the dry periods, something like an accordion expanding and contracting.

19) Seaweed or algae

Some plants must be able to withstand alternating dry and wet conditions like this seaweed along the Pacific coast. They not only must be able to adjust to the dry and wet, but also need to be fastened to rocks to prevent them from being washed away.

20) Yellow rose

Plants have a variety of ways to accomplish the reproducing of themselves. Before this rose can produce seeds the pollen must be transferred to the pistil of the flower. Some plants have colorful petals and nectar glands that attract insects. As the insects crawl into the flower they brush the pollen from anthers to pistil and complete the necessary transfer. Can you find the bee inside this flower?

21) Parachute plant

This parachute plant has a very unusual shaped flower and can only get pollinated if an insect will crawl through the narrow openings in the sides of the flower.

22) Century plant

Notice the plant in the center with the tall flower stalk. In the next slide we want to look closely at the flowers on this stalk.

23) Century plant flowers

What flower part is missing from these flowers? There are no petals. These types of flowers allow the wind to cause the pollination instead of insects.

Plant Adaptations - Slide Set Narrations (Continued)

24) Walking stick cactus

The flower on this walking stick is somewhat between the rose and other desert flowers in structure. There are some petals that might attract insects, but the flower is also rather open so wind can blow the pollen.

25) Star cactus

Carefully look for the flowers on these plants. Do you see the brown and yellow star shaped flowers? These flowers attract flies that normally lay their eggs in spoiling meat of dead animals. As the flies are laying their eggs, they brush the pollen from the anthers onto the pistil of the flower, thus doing the pollination.

26) Jumping cactus

Many plants have the ability to produce a new plant from a piece of the old plants. This jumping cactus has thorns that point backwards. As you walk by it, the thorns can catch in your clothing without you being aware. The clothing stretches out and pulls on the cactus until a branch of the cactus breaks. The cactus branch then flies into you. People used to think the cactus jumped at them, because they were unaware the cactus had caught on their clothes. If the cactus branch falls in a suitable place, it will grow into a new plant.

27) Budding cactus

Other plants have the ability, like this cactus, to produce buds or little plants that can break off and grow into new plants.

SOME WAYS MAN USES PLANTS - SLIDE SET NARRATIONS

This series of slides illustrates some of the common as well as less known ways man depends on and uses various types of plants. This set is not intended to demonstrate all the ways man utilizes plants, but rather to stimulate student thinking about the variecy of uses man makes of plants.

1) Medicine plant

Man has used this plant for many purposes. The juice from this medicine plant has a chemical that has been used in treating burns.

2) Blue Indigo

The juice from the blue indigo plant can be used as a blue dye.

3) Blacksamson

The sap from the blacksamson has been used for treating mumps, toothaches, burns, wounds, sore throats, and other ailments.

4) Prickly pear cactus

Many people find the prickly pear cactus very good eating once the outside peel and thorns are removed.

5) Persimmon

Oppossums as well as people enjoy the fruit of the persimmon tree in the fall. Can you see the young green fruit on this tree branch?

6) Fig tree

The fig tree fruit is another one which man enjoys eating.

7) Ginger

The roots, stems, and leaves of the ginger plant can be ground and used as a spice.

8) Banana

Few people or other animals can resist the fruit of the banana tree.

9) Coffee tree

The seed of the coffee tree is widely used in making a beverage.

10) Cheese plant

The tropical cheese plant produces an ear like fruit, much like a common ear of corn. The kernels on the outside of the cob are poisonous, but the cob like the center part is widely eaten by tropical people.

Some Ways Man Uses Plants - Slide Set Narrations (Continued)

11) Yucca

The sharp point on the yucca leaves were used as needles, the stringy fibers as thread, and the juice from the roots as soap by the Indians.

12) Eroding bank

Plants of many types are important in preventing erosions of soil. The roots tend to hold the soil and slow the erosion caused by wind and water. For this reason man often plants grasses and other plants to cover bare soil.

13) Rubber tree

The rubber trees have a sticky sap from which we can make natural rubber.

14) Norfolk Island Pine

The Norfolk Island Pine not only is used as a house plant, but is an important source of lumber in some areas of the world.

15) Hemlock trees

The hemlock tree is a source of lumber and pulp which can be used in making cellophane, paper, and rayon.

16) Timber Clearcutting

This is an example of a wooded area that has been recently harvested for man's use. When all trees in an area are harvested at one time like this it is called clearcutting.

17) Grassland

Large areas of our land produce grasses used for grazing cows, sheep, and other domestic and wild animals.

18) Wheatfield

Much of the native grasslands of the world have been changed by man to domestic grasses such as these wheatfields of Kansas. Domestic grasses like wheat, corn, milo, etc. produce more of the grains man likes for food that were being produced by the native grasses.

19) Haystacks

Many plants, such as this alfalfa, are grown by man as a food source for the animals that man in turn uses his food.

Some Ways Man Uses Plants - Slide Set Narrations (Continued)

20) Fiddle Leaf Fig

Many plants, like this fiddle leaf fig, are used for home decoration. The fruit produced by this fig is not edible.

21) Bougoinvillea

The bougoinvillea vines completely cover many homes in southern states. The beautiful pink color is from specialized leaves, not the flowers.

22) Orchids

The orchid is another flower man has adapted for his enjoyment.

23) Ski Slopes

Man also modifies the natural plant growth in some areas like these ski slopes in Colorado for his pleasure.

APPENDIX B

Diagrams, Charts, And Maps

The diagrams, charts, and maps included in this appendix can be used as student handouts, transparencies, bulletin board material, or in other ways desired by the teacher. Teacher suggestions for using each diagram, chart, or map is given within the topics.

Typical Plant Diagram B-2

Tree Cross-section. B-3

Mosses and Lichen Diagram Key B-4

Algae Key B-4

Mosses and Lichen Diagrams. B-5

Algae Diagrams. B-6

Fern Diagram Key. B-7

Fern Diagrams B-8

Mold and Fungi Diagram Key. B-9

Mold and Fungi Diagrams B-10

Food Chain Diagrams B-11

Plant Adaptations Diagram Key B-13

Plant Adaptation Diagrams B-15

Plant Seed Adaptation Diagram Key B-18

Plant Seed Adaptation Diagrams. B-19

Using Plants to Reduce Noise Illustrations. B-20

Major World Biomes. B-22

Biome Summary Chart B-23

TYPICAL PLANT DIAGRAM

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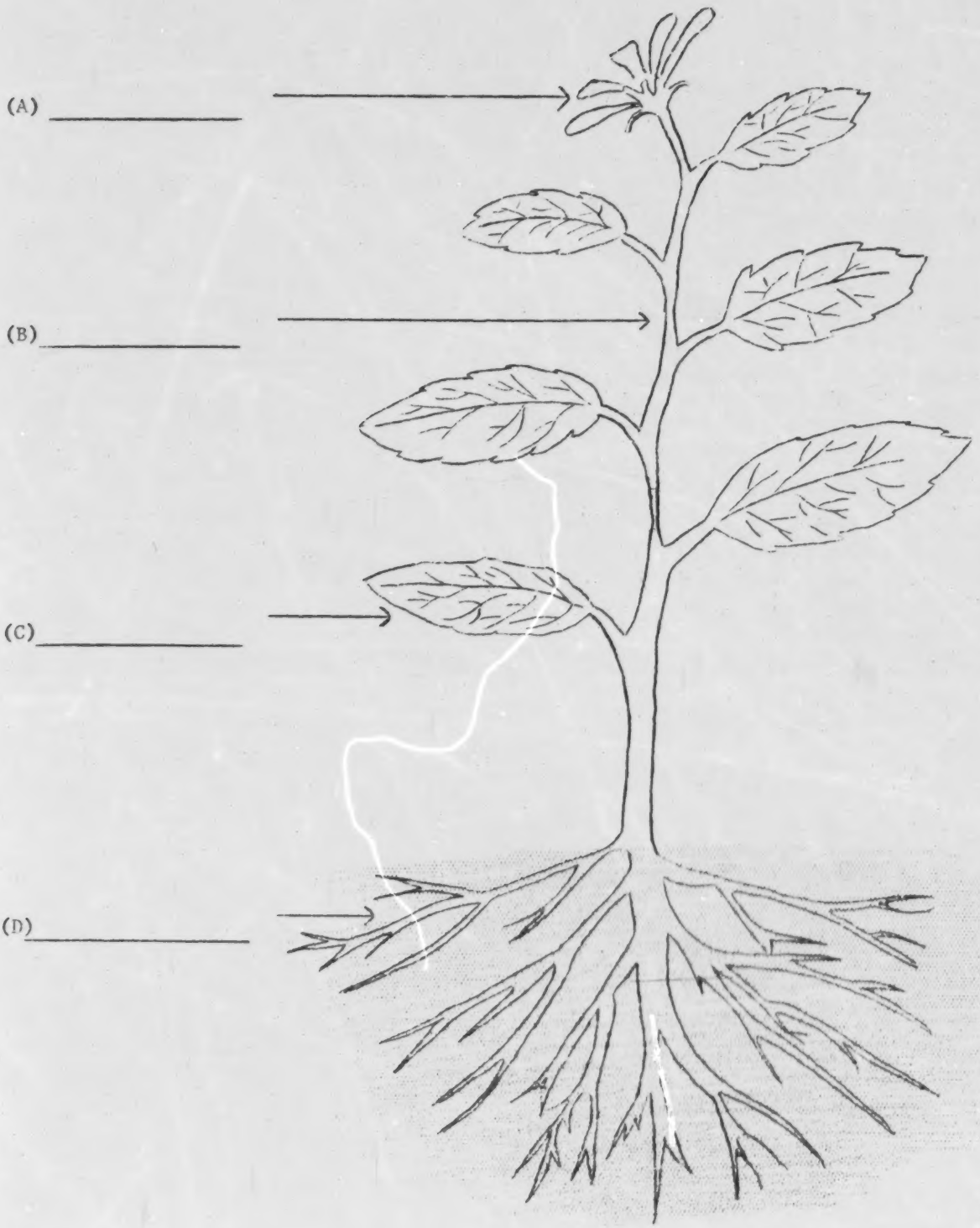

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TREE CROSS - SECTION

Outer bark

Location where a branch is attached

Location where new wood and bark is being formed

Dark line resulting from growth during the winter

Oldest wood in the tree

Lighter colored wood resulting from growth during the summer

MOSSES AND LICHEN KEY

1. Spineleaf moss - one to two inches tall, common on shady banks
2. Cord moss - less than one-half inch tall, grows on burned over soil or limestone areas
3. Apple moss - one to three inches tall, has small apple shaped spore capsules, found in rocky soil in woodlands
4. Tree moss - one to two inches tall, appearance of tiny trees, grows as clumps or separate plants in swampy ground in mountainous regions
5. Common Water moss - grows submerged in clear brooks
6. Shield lichen - found on trees and logs, grayish-green, leaf-like, up to six inches across, lobed and jogged margins
7. Spoon lichen - trumpet-shaped stalks, up to three inches tall, grows at high elevations through most of North America, usually grows on soil
8. Golden lichen - spreading entangled branches, usually yellow-orange color, grows on trees in northern coastal areas

ALGAE KEY

All of these algae plants are microscopic in size. When abundant and viewed with the naked eye in their natural environment, they will appear as varing shades of green slime or clumps. These diagrams are greatly enlarged to illustrate some of the ways by which the structure of algae plants differ. The names are provided so students can do further research on specific ones if they wish.

1. Chroococcus
2. Ulothrix
3. Oscillatoria
4. Gymnodinium
5. Gonyaulax
6. Nostock
7. Merismopedia
8. Euglena
9. Phacus
10. Tribonema
11. Volvex
12. Ulothrix
13. Botrydium
14. Tabellaria
15. Asterionella
16. Fragilaria
17. Cyclotella
18. Closterium
19. Pediastrum
20. Pandorina
21. Diatoma
22. Spirogyra

MOSSES AND LICHEN DIAGRAMS

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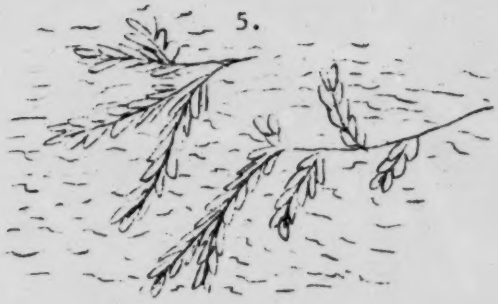
1.

2.

3.

4.

5.



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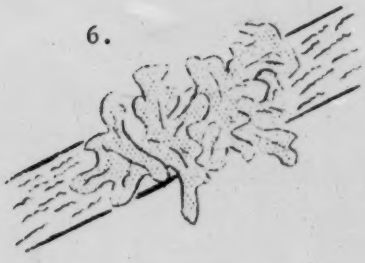

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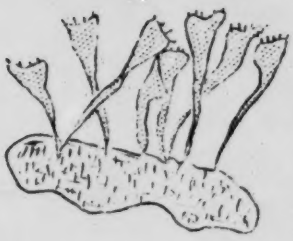

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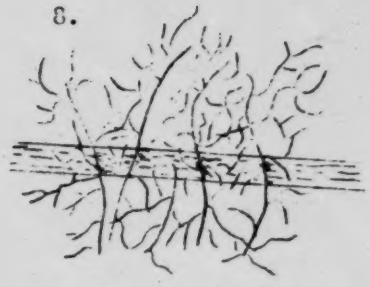

ALGAE DIAGRAMS

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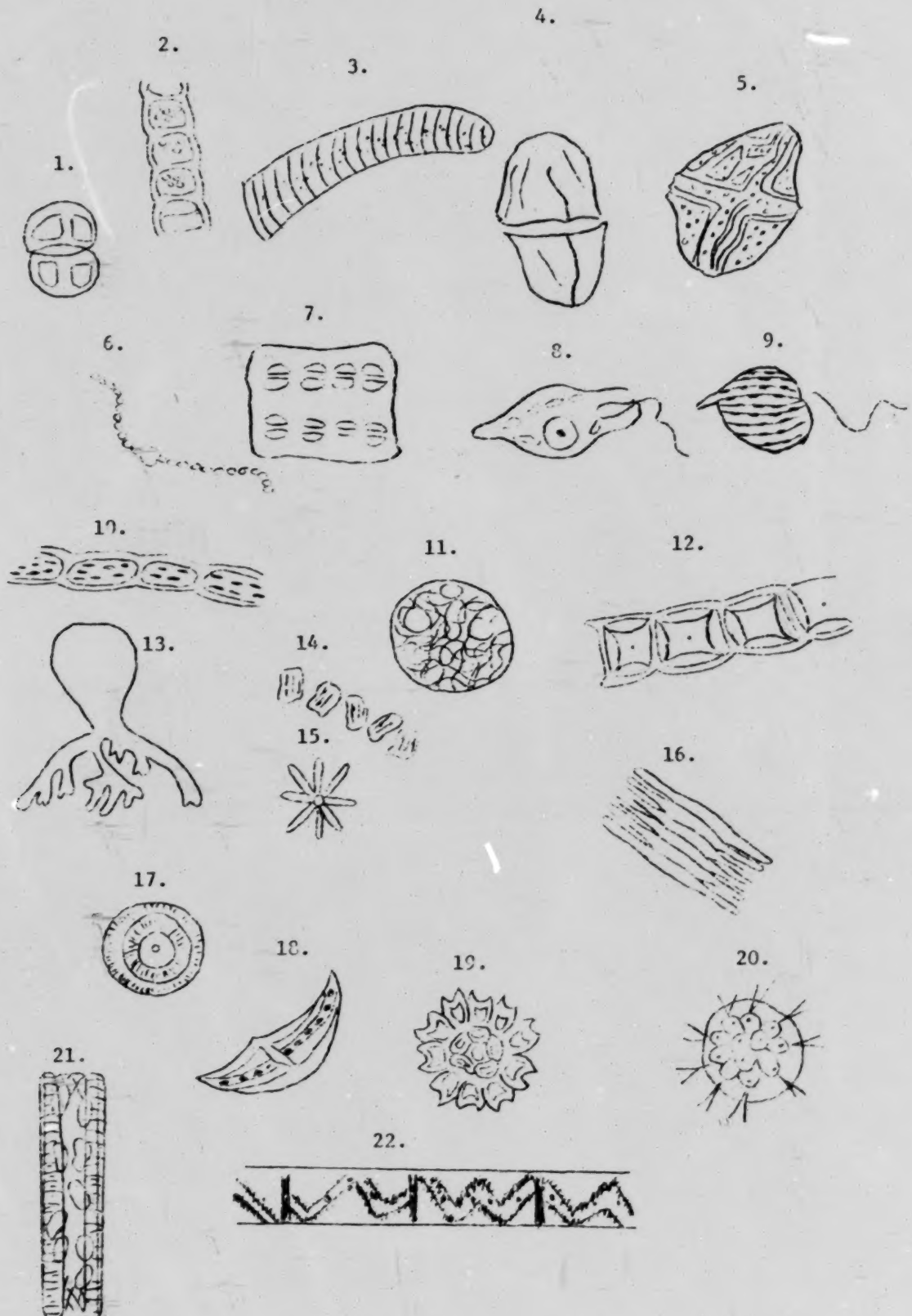

FERNS KEY DIAGRAM

1. Fern leaflet with spore cases (dots) - Ferns do not produce flowers and seeds. The fern plant produces spores which are somewhat similar to seeds. The spores are formed inside spore cases usually found on the underside of the leaflets.

2. Fern spore case (greatly enlarged) - When the spores are ripe the case breaks open and the dust like spores are blown out.

3. Wall rue - Found on sheltered cliffs and crevices of limestone outcroppings, fragile, not common.

4. Water shamrock - An aquatic fern, found in still bodies of water, such as ponds and lakes, roots are in the soil while leaves float on the water surface.

4A. Top view of water shamrock leaves.

4B. Water shamrock spore case growing from root stock.

5. Mosquito fern - Small free floating aquatic fern, when in dense growth it supposedly smothers mosquite larvae, found in standing water.

6. Walking fern - A rare fern, found on shaded moss covered limestone cliffs, boulders, and outcroppings, leaf tips sprout new plants, a few found in all states.

7. Curly grass fern - Very small plant, found in wet and very acid soils, such as bogs, in the United States found only in New York and New Jersey.

8. Ebony spleenwort - Grows up to 18 inches high, common in shaded woods, fields, banks, and fences where there is well drained rocky soil.

9. Polypody fern - Common in most of the United States, lives in rich, shallow, slightly acid, and shaded soil, grows largest along waterways, rare in sandy rockless coastal areas.

FERNS DIAGRAM

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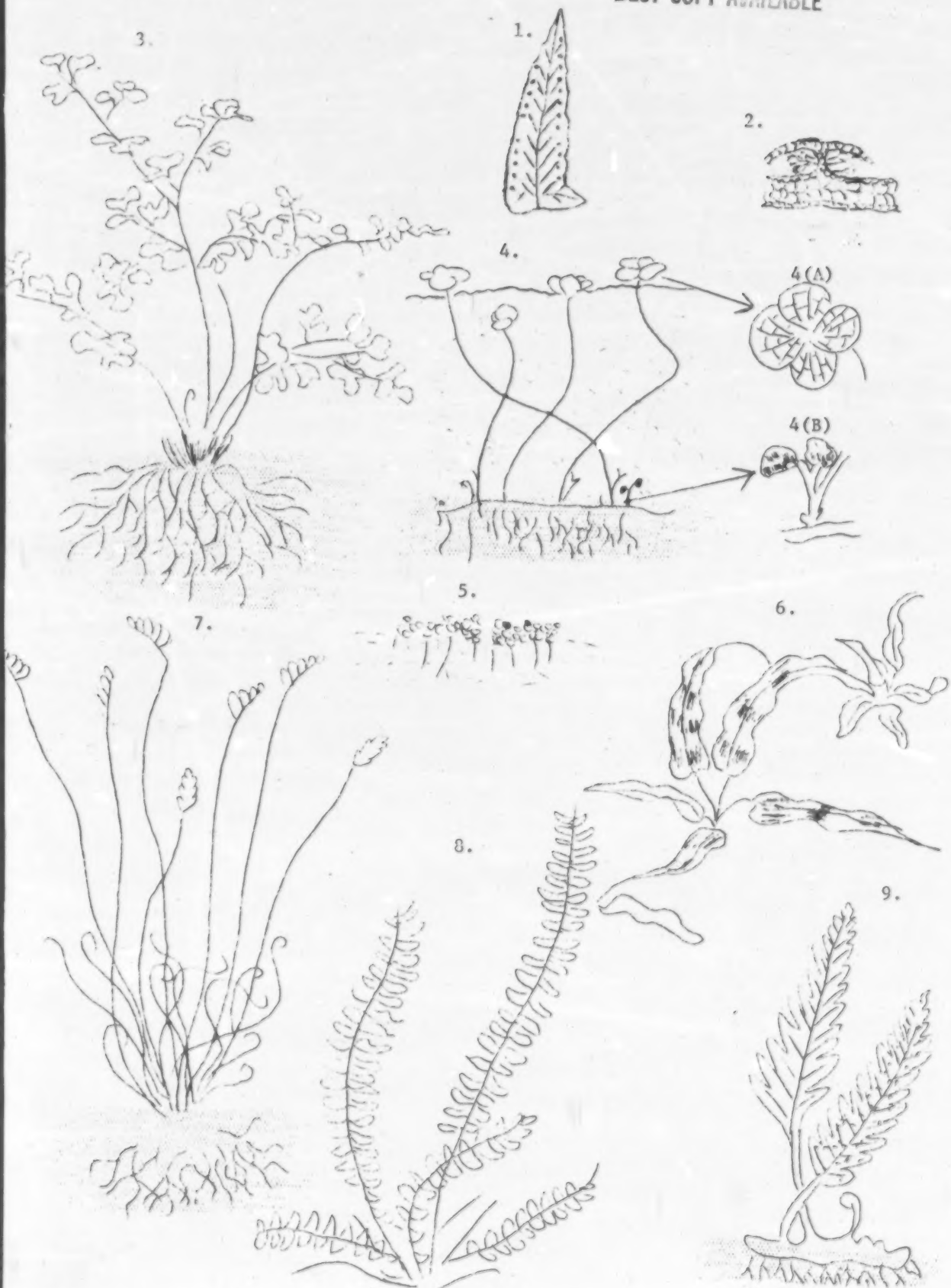

MOLD AND FUNGI KEY*

1. Slime mold - unusual plant that flows along the ground, will appear as a jellylike glob among decaying leaves.

2. Yeast - miscroscopic, reproduces by budding, used to ferment sugar. Always present in the air as spores.

3. Shelf or bracket fungus - grows from sides of dead logs and trees.

4. Bread mold - appears as black powder on bread, source of some medicines.

5. Pencillia - usually green color, found on citrus fruits, first source of pencillin, used in some cheese processing.

6. Morel - one of the edible mushrooms, found in the springs in wooded areas.

7. Coral fungus - very tough and bitter, found in woods.

8. Aspergilli - often found as mildew on walls, leather, and fruits.

9. Horn of plenty fungus - trumpet shaped, edible, found in woods.

10. Gill fungus or toadstool - some are deadly poisonous, grows in soil or rotted logs.

11. Bird's nest fungus - less than one-half inch in diameter, grow on decaying material.

12. Stink horn - very foul-smelling spore caps, attract flies.

13. Clitocyber fungus - of en poisonous, gills on outside.

*Numbers 1, 2, 4, 5, and 8 are greatly enlarged to show the structure.

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MOLD AND FUNGI DIAGRAMS

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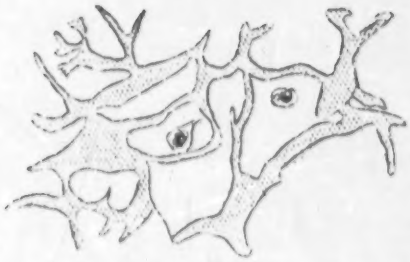

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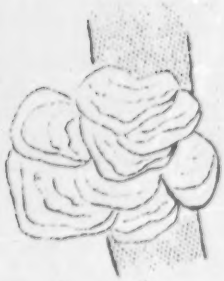

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GRASSLAND FOOD CHAIN

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Grass - Captures energy from the sun and combines it with water, carbon dioxide, and minerals to produce food.

Prairie dog - Depends on the grass and other green prairie plants for its food supply.

Coyote - Depends on the prairie dog and other small animals for a food supply.

Bacteria and mold - These decomposers will return the material in the coyote's body to the soil when the coyote dies, if it is not eaten by some scavenger.

POND FOOD CHAIN

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Algae - Along with other green plants in the water, the algae captures energy from sunlight, and combines it with water, minerals, and carbon dioxide to make food.

Snail - The snail depends on the algae and other green plants for its food supply.

Fish - The fish eats snails and other small animals, as well as some green plants, in order to obtain its food supply.

Raccoon - The raccoon captures fish and other small animals as part of its food supply.

Mold, fungi, bacteria - The mold, fungi, and bacteria decomposes dead bodies of raccoons, other animals, and plants returning the materials back to the soil.

PLANT ADAPTATIONS (1)

1. English ivy - Adventitious roots along the stem will support the vine on trees and walls. This allows the plant to reach more sunlight.

2. Corn - Prop roots develop above the ground and help support the corn plant, acting as braces or guy wires.

3. Joshua tree - The very deep roots are able to reach a water supply in the desert.

4. Sonneratia - One of the varieties of mangrove trees. The shoots projecting upward from the roots obtain the oxygen needed by the roots. There is not enough oxygen available in the tidal or swamp water where the mangrove trees are found.

5. Bruguiera - Another variety mangrove tree with a different type of root adaptation for obtaining oxygen.

6. Legume plant - The legume plants, clover, beans, etc., support nitrogen fixing bacteria on their roots. These clusters of bacteria help the legumes by taking nitrogen from the air and changing it into a form that can be used by the legumes.

7. Grape - Many of the climbing vines, such as the grape, have tendrils that are used to fasten onto tree limbs. The tendrils have the ability to twist around branches and attach themselves.

8. Peanut - Tendrils (branches from the stem) of the peanut plant push themself into the ground before producing peanuts. This way the seeds are self planted.

9. Needle grass - As the humidity of the air changes the thread or awn fastened to one end of the seed twist. This twisting motion causes the seed to move over the ground to a soft place, then the seed forces itself into the ground.

10. Tulip - Tulips prefer to grow in sunny places. If planted in a shaded place they will send out a runner into a sunny area. The stored food is gradually transferred into a new bulb at the end of the runner. The tulips move into sunlight by moving their bulb.

PLANT ADAPTATIONS (2)

11. White clover - The runners have the ability to produce new plants, thus the clover can spread without the use of seeds.

12. Mangrove tree - The many branched spidery-like roots are needed to support the mangrove tree that lives in muddy sand. A single trunk could not support a large tree in the soft soil and withstand the tidal wave action.

13. Water lily - The long stems allow the water lily leaves to float on the water surface where they can receive the most sunlight. Also the stems contain air tubes that take oxygen to the plant roots.

14. Myriophyllum (double life plant) - This is a fresh water plant with two completely different types of leaves. The leaves in the water are long and narrow and have special structures to help them collect carbon dioxide from the water. Also the shape of the leaves in the water allow maximum area exposed to sunlight regardless of how the water moves them. The leaves above the water are flatter, have one side specially structured for receiving sunlight, and contain more woody-like material to hold them upright.

15. Gulf weed - The bladders or floats along the stem helps support the gulf weed in its ocean environment.

16. Duckweed - The duckweed plants are adapted to float on the surface of standing water.

17. Tumbleweed - Tumbleweeds break from their roots and roll across the land. As the plant rolls the seeds are scattered.

PLANT ADAPTATIONS (3)

18. The corpse flower - A tropical flower in which the center spike grow to be eight feet tall. The flower produces a very strong smell like rotting meat. This smell attracts scavenger beetles which crawl into the flowers. As the beetles move from flower to flower they carry the pollen from the male flowers to the female flowers, assuring pollination.

18A. Enlarged lower part of the corpse flower.

19. Cereus - A desert plant that stores water in the underground bulbs.

20. Sandbur seed - The claws on the sandbur seed attach to animals. This transports the seeds to new locations.

21. Bromeliads - Plants that live in the top of tropical trees. The bromeliads roots attach to tree limbs, but do not take minerals or water from the tree. They are not parasites. They collect rain water, up to several quarts, within their tightly fitted leaves. Small hairlike structures absorb this water into the plant. The plants depends on dust and other things falling into their water pool for the necessary minerals.

22. Dwarf mistletoe - When the seeds ripen they are shot from their pod. Sometimes they travel up to fifty feet. This mistletoe is sometimes called the pop gun plant.

23. Pitcher plant - The leaves of the pitcher plant by using chemicals, downward point bristles, and their shape can capture small insects. Once trapped the insects are digested by chemicals produced by the plant.

24. Witch Hazel - When the woody witch hazel seed pod dries it snaps open and the seeds are sent on their way with an explosive force and sound.

PLANT ADAPTATION DIAGRAMS (1)

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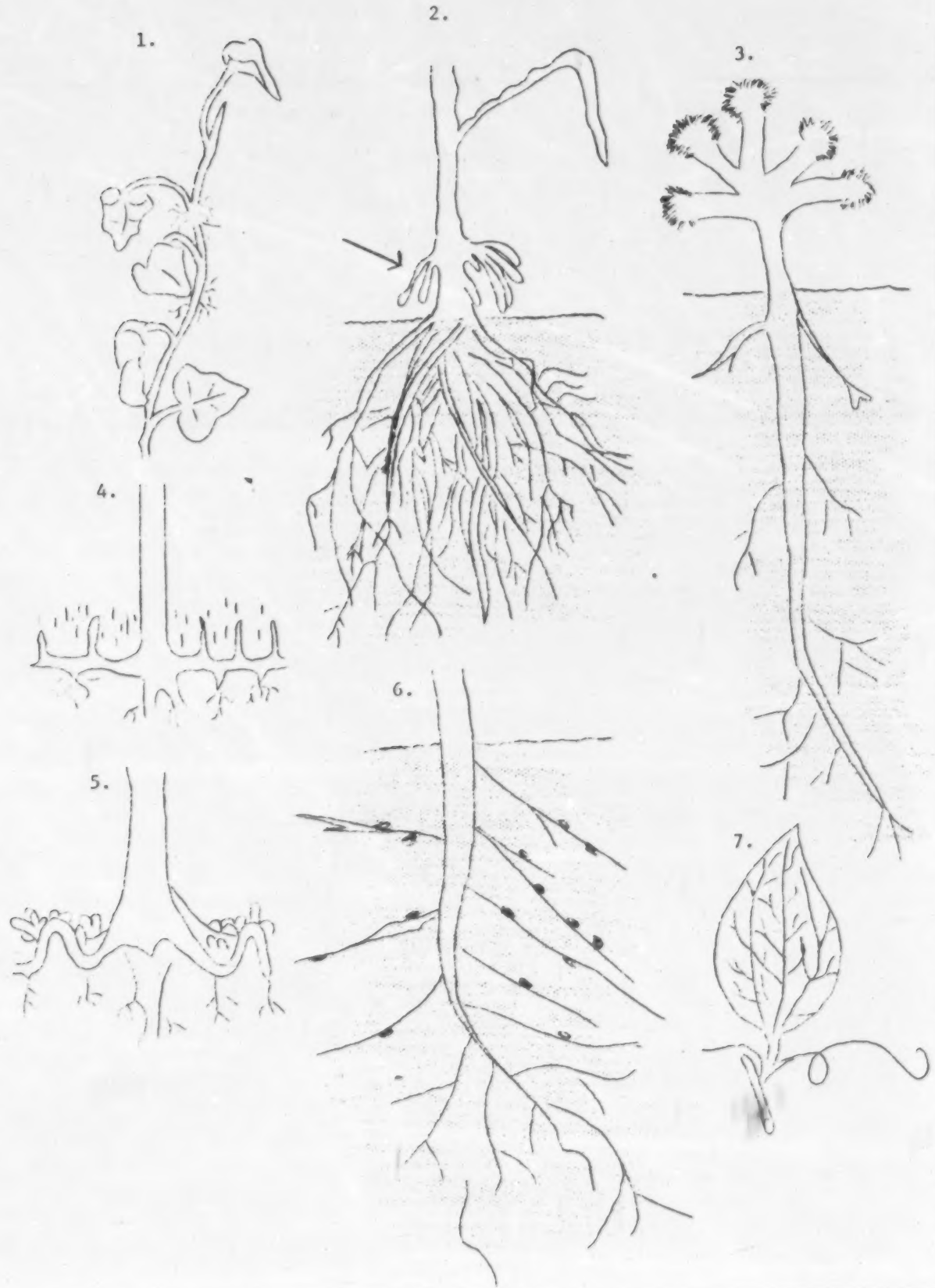

PLANT ADAPTATION DIAGRAMS (2)

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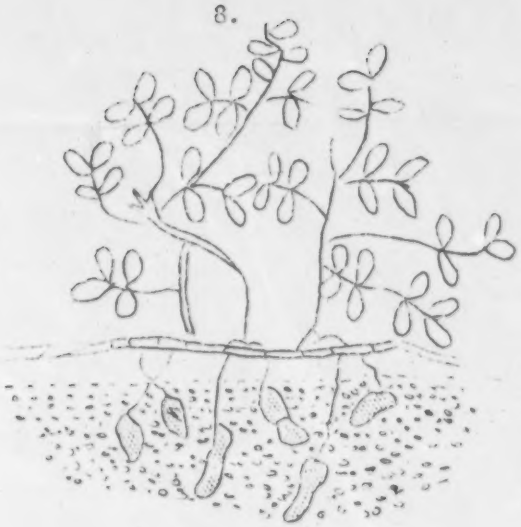

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PLANT ADAPTATION DIAGRAMS (3)

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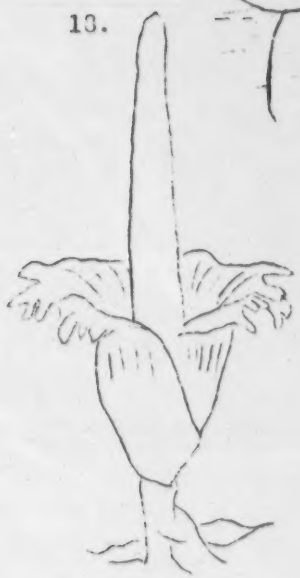

18(A)

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24.

PLANT SEED ADAPTATION DIAGRAM KEY

1. Dandelion Seed: Seed contains an umbrella which allows the wind to carry the seed away from the parent plant.

2. Milkweed Seed: Seed contains an umbrella which allows the wind to carry the seed away from the parent plant.

3. Cocklebur Seed. Hooks covering the seed pod attach to animal fur and clothing and are carried to new locations.

4. Maple Seed: Seed wings act like helicopter blades when the seed falls, causing it to move away from parent plant.

5. Poppy Seed Capsule: Holds open around the top of the capsule and when the capsule is shaken by wind or passing animals, the seeds are spread like pepper from a shaker.

6. Beggar Tick Seed: Barbs over the seed surface attach to animal fur or clothing and are carried to new locations.

7. Filares Seed: The seed acts like a cork screw. As the humidity changes, the tail curls up causing the seed to screw itself into the ground.

8. Touch-Me-Not Seed: After ripening, when the pod is touched, the pod snaps open throwing the seeds away from the parent plant.

9. White Ash Seed: Seed wing caused the seed to be carried by the wind to new locations.

10. Slippery Elm Seed: The thin membrane surrounding the seed helps the seed float in the wind.

11. Apple: Animals eat the complete apple. Seeds are not digested and grow wherever the animal's waste material is dropped.

PLANT SEED ADAPTATION DIAGRAM

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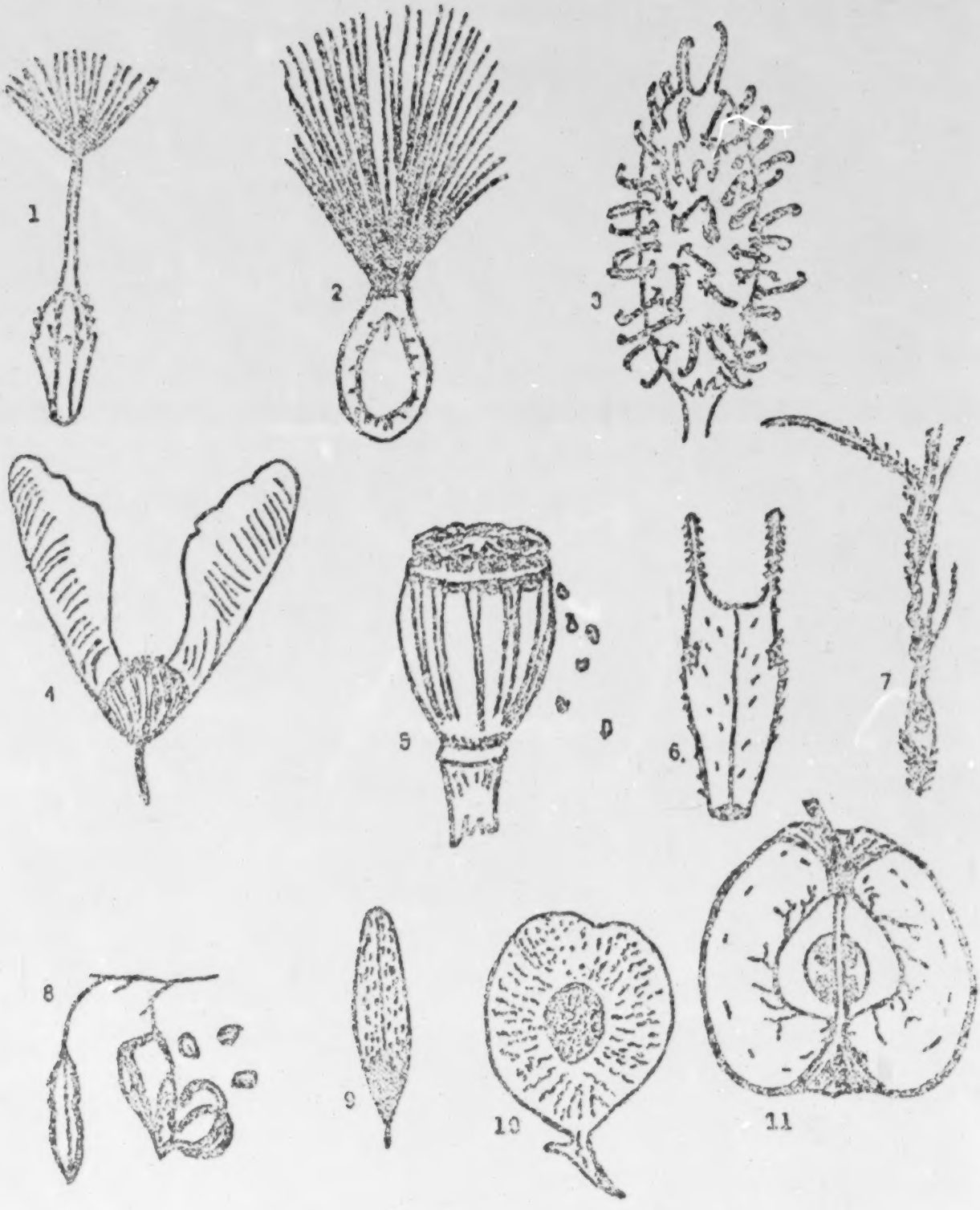

USING PLANTS TO REDUCE NOISE (1)*

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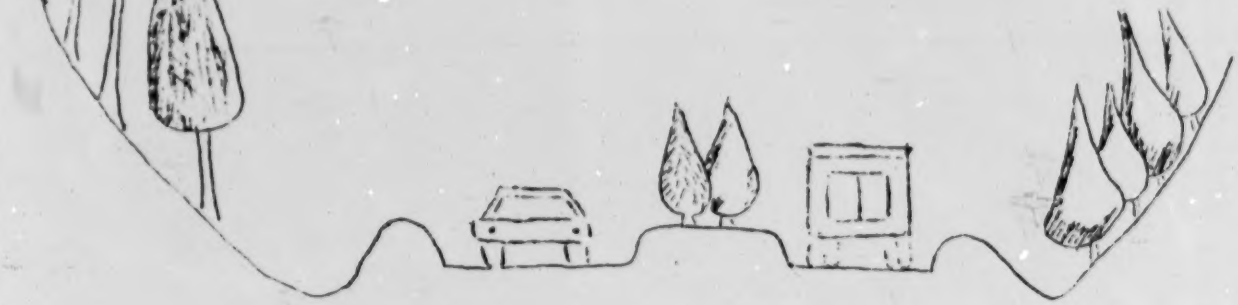
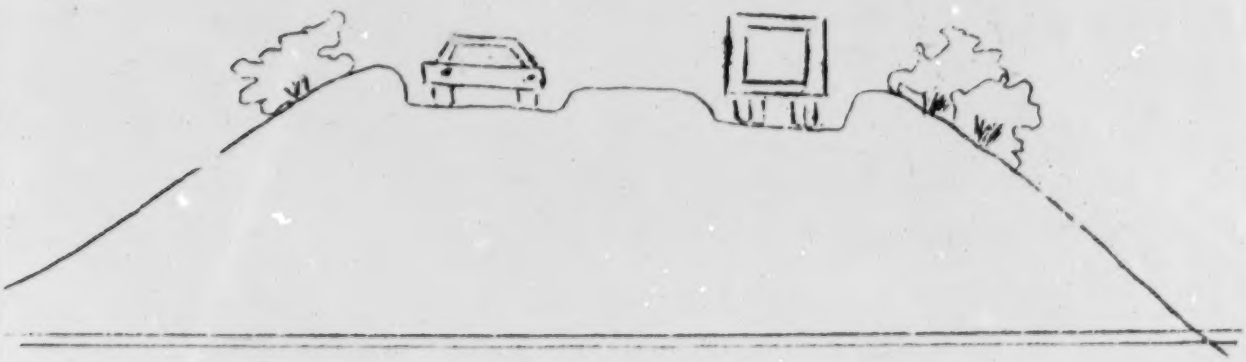
I. Coniferous plants arranged in this pattern will reduce vehicle noise between 70 to 80 percent.



II. Deciduous shrubs arranged in this pattern will reduce vehicle noise by 20 to 50 percent.



III. The evergreen hedge reduces the refuse department pick-up noise by 50 percent.

*Source: Plants, Man, and Environment, Cooperative Extension Service, Kans. St. Univ.

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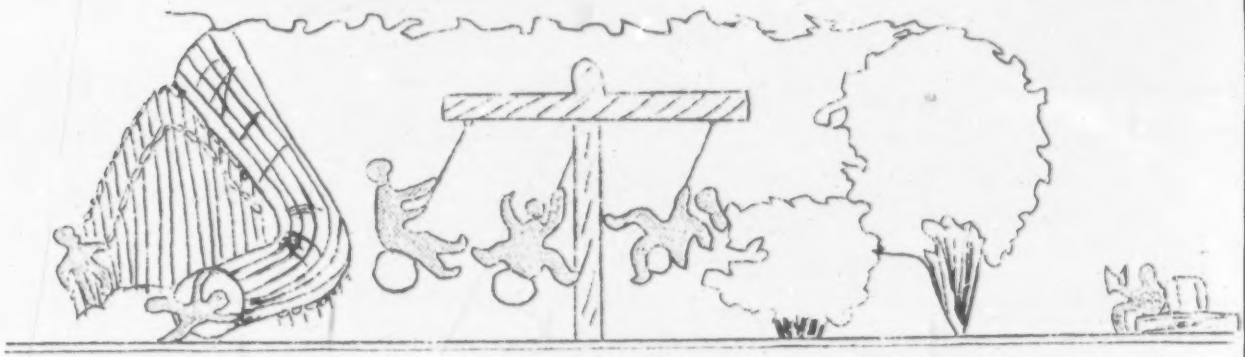
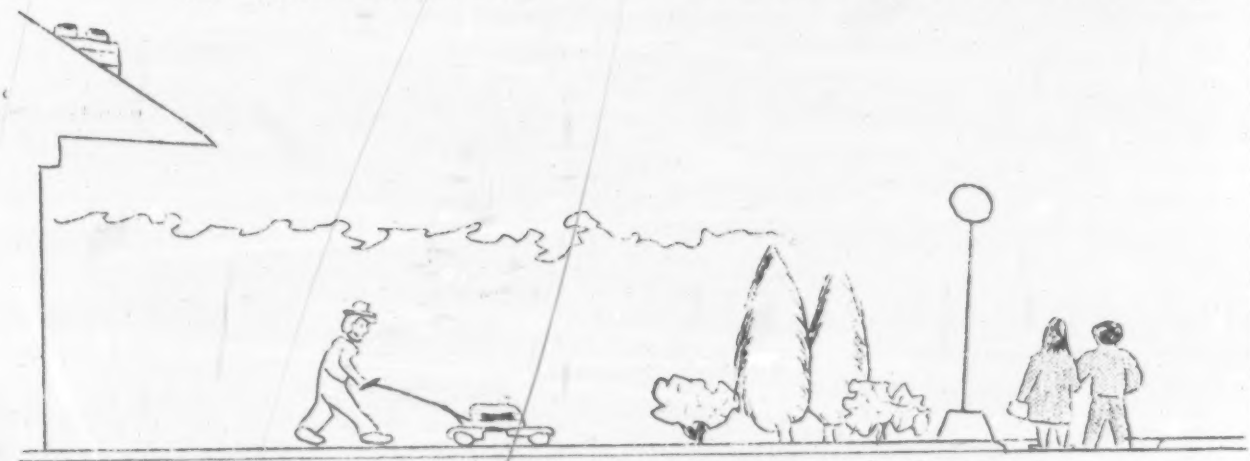
USING PLANTS TO REDUCE NOISE (II)*

IV. The plant island reduces the shopping center pedestrian sounds by 25 percent.

V. Noise from children playing can be reduced 50 percent by the trees and shrubs.

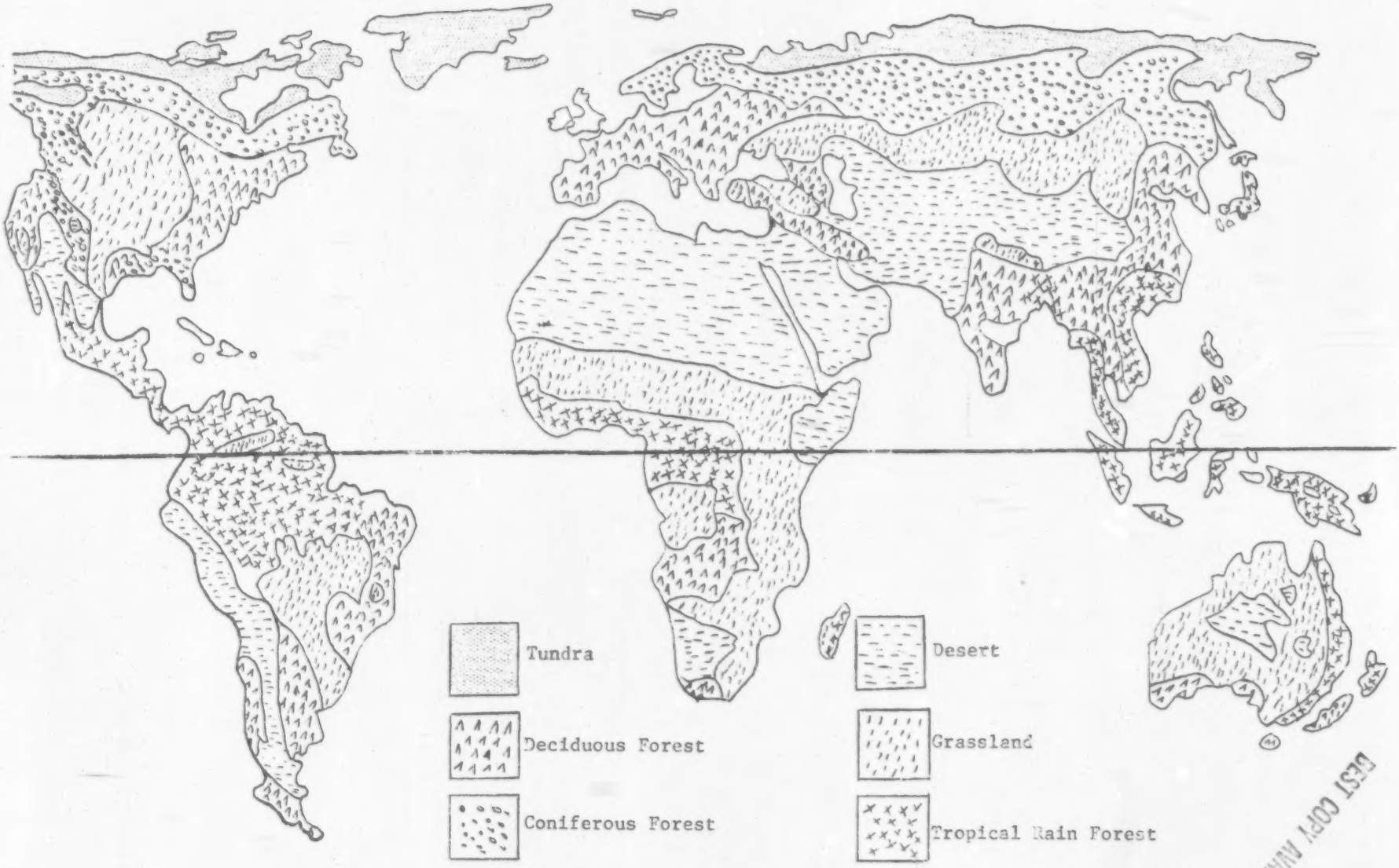


VI. Mixed hedge plants can reduce lawnmower noise by 40 percent.



*Source: Plants, Man, and Environment, Cooperative Extension Service, Kansas State University, Manhattan, Kansas.

MAJOR WORLD BIOMES



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BIOME SUMMARY CHART

Biome	Most Common Plant Types	General Climate	Location(s) in the World	Man's Use of Area	Other Comments
Coniferous Forest					
Deciduous Forest					
Chaparral					
Tropical Rain Forest					
Tundra					
Grassland					
Desert					
Water					

APPENDIX C

Major Habitats (Biomes) of the World

The short summaries of each of the major habitats included in this appendix can be used by individual student, small groups, as the basis for classroom discussion, or as the starting point for further library research into the various habitats. Each summary is followed by sample questions that can be used to stimulate discussion and comparison between the habitats.

Teachers should refer to Topic IV for a more complete and extensive set of activities using these short summaries.

Deciduous Forest. C-2

Tropical Rain Forest. C-4

Coniferous Forest C-6

Chaparral C-8

Grassland C-9

Tundra. C-11

Desert. C-12

Water C-14

DECIDUOUS FOREST

Just like people, forests come in different kinds, sizes, and shapes. A deciduous forest contains a wide variety of trees and other plants, but nearly all the plants either die or lose their leaves during the winter season. The name deciduous came from the yearly falling of the tree leaves. Forests of this type can be found in eastern United States, Great Britain, Central Europe, and Asia. The kinds of trees in the various areas will be somewhat different, but all of them will loose their leaves during the winter season.

These deciduous forest areas will have approximately forty inches (100 centimeters) of rainfall during the year and rain will occur during all seasons. The temperature varies greatly from long warm summer days to short cold winter days

The deciduous forest can be thought of as a living system containing many layers. The top layer, 50 or more feet high, is often called the canopy and consists of mostly deciduous trees. These trees could be oak, hickory, maple, cottonwood, elm, birch, ash, and others. These trees, by reaching over all others, get the most sunlight and therefore are the biggest producers in the deciduous forest. They must also be able to stand up to strong winds and hard rains. These trees are our source of hardwood lumber used in making things like furniture.

The layer just under the canopy layer is sometimes called the understory. The understory, around 20 feet high, is made up of trees that will never grow very tall, such as young canopy trees and dogwood, redbud, and pawpaw trees. These trees do not require as much sunlight and cannot stand the strong wind and rain.

Just below the understory layer is the four to eight feet high shrub layer. This is the layer that often makes it hard to walk through the deciduous forest because of the thick and sometimes thorny branches of the bushes and shrubs. Sumac, gooseberries, buck brush, and raspberry are common plants in the shrub layer. These plants usually have many small and flexible stems. Most of the shrubs grow rapidly and produce seeds or fruit in the early spring before the canopy and understory layer develop leaves that block out most of the sunlight.

Between the shrubs and the ground is another layer called herbs. The herbs are mostly soft plants such as wildflowers, ferns, and grass. These plants like the shrubs grow most rapidly during the spring while more sunlight can reach them.

The bottom layer or forest floor receives the least sunlight and therefore has the least number of green plants. The most important plants on the forest floor are the fungi, mold, bacteria, and other decomposers. They are constantly breaking down the dead wood and leaves from the other layers returning the minerals back to the soil for reuse. In addition to the decomposers, moss and sometimes algae can be found on the forest floor. The moss and algae can live here because they require a cooler, shaded, and moist area and little sunlight.

All the various green plants of a deciduous forest are using the sun's energy, minerals and water from the soil, and carbon dioxide from the air to make food. Some of this food is used by the plants producing it, but a lot of extra food is made that can serve as food for animals.

Each layer of the deciduous forest has a certain group of animals that lives in or gets its food from that layer. For example squirrels, owls, hawks, orioles, and leaf eating insects use the canopy layer. The understory provides food or shelter for warblers, woodpeckers, and red-eyed vireos. The shrub layer provides nesting areas and food for many birds, food for many insects, and young twigs for deer to eat. The forest floor is a source of shelter and food for many crawling, burrowing, and walking animals of all kinds.

In addition to the animals that eat the various plants, many animals live in the deciduous forest that eat the animals that eat the plants or eat animals that eat animals. This group would include animals like bobcats, coyotes, spiders, eagles, and other predators. Another special group of animals found in the deciduous forest is the scavangers. Scavangers like crows and vultures keep the forest clean by eating other animals that have died or been killed.

The deciduous forest is a very complex living system that is able to survive in a particular climate if all its parts (plants and animals) are allowed to do their job. When man removes some plants or animals the system gets out of balance. If given enough time, a natural balance will return, but might be slightly different than the original system.

Questions and Activities

1. What kind of climate must there be in order to have a deciduous forest?
2. Why is there no deciduous forest in western Kansas?
3. Sketch a diagram of a deciduous forest showing the various layers.
4. List 10 producers (green plants) found in a deciduous forest.
5. What kind of decomposers would you find in a deciduous forest?
6. Diagram five different food chains that can exist in a deciduous forest.
7. Where are most of the deciduous forests found in the United States?
8. Why is a deciduous forest called a deciduous forest?
9. What does man get from deciduous forests?
10. Do library research to find what happens to leaves in the fall to cause them to change color.
11. In the library find out what causes leaves to break away from tree twigs in the fall.
12. What causes the rings one sees on deciduous tree stumps or cut limbs?
13. What happens to the animals that live in the deciduous forest when the winter season comes?

TROPICAL RAIN FOREST

Movies have often presented the jungle type forest as being typical of the tropical rain forest. The movies show thick tangled vines, snakes all around, quicksand, tigers, gorillas, piranhas, crocodiles, lions, other beasts, orchids, and colorful birds. These descriptions resulted from early travelers that never left their boats and had great imaginations. Parts of this description actually describe the rain forest along the river banks, but only slightly describe accurately the interior of the rain forest.

A more factual picture of the tropical rain forest would be an area with very thick, tall trees, and nearly bare ground. The tree tops will include a variety of smaller plants, birds, and other animals.

The tropical rain forest is generally located between the Tropic of Cancer and the Tropic of Capricorn. There is very little variation in the seasons and the temperature is normally between 68° and 82° F. Daily thunderstorms keep the air very moist and produce around 80 inches of rainfall each year. People find the tropical rainforest to be very uncomfortable due mostly to the high humidity, not the temperature.

It is not unusual to find fifty different kinds of trees growing in one acre of rain forest. The trees continue growing the year around and produce a very thick leaf cover in their tops, allowing only a little sunlight to reach the ground. Around three hundred different kinds of birds and many other animals live in the rain forest. Most of these animals live among the tree tops where most of the food is produced. Shorter trees that do not require much sunlight are found growing below the tall trees. Vines will climb up the trees and produce their leaves among the top layers.

Orchids are unusual plants that do not grow in soil, but grow hanging on sides of trees and tree limbs. They get the minerals and water they need from the air and tree surface. Their roots do not grow into the tree so they are not parasites. Many other rain forest plants grow similar to orchids. The plants that grow in this way are known as epiphytes.

The tropical rain forest is a very colorful place, especially when viewed from above. Some of the great variety of trees and other plants are always in bloom or producing fruits which are often large and colorful. Tropical birds with bright colored feathers and beaks add to the forest's beauty.

The only areas similar to a tropical rain forest found in the United States are in the Everglades National Park, in southern Florida, in Hawaii, and in Puerto Rico.

Natives have always done some farming in the tropical rain forest. They burn the plants from an area and farm it for one or two years. The heavy rainfall washes the minerals from the soil causing it to become useless for farming. In about twenty years the rain forest growth reclaims the abandoned farmland. By constantly moving to new areas the native farmers do not cause great amounts of permanent damage. Today large scale farming is moving into the rain forest. After a few years of large scale farming, the soil becomes as hard as a rock and will not let water soak in. Once the soil becomes this hard it is nearly ruined and will become a pavement-like wasteland.

Questions and Activities

1. What kind of climate causes a tropical rain forest?
2. Would you expect to find many old dead logs on the tropical rain forest floor? Why?
3. Why do few green plants grow on the tropical forest floor?
4. Why can such a large variety of plants and animals live in the tropical rain forest?
5. What are the basic needs of plants?
6. What are the basic needs of animals?
7. Why do people feel uncomfortable while traveling in the rain forest if the temperature seldom gets over 80° F.?
8. Why does farming not work in the rain forest area when it can raise so many big plants?
9. Where is most animal life found in the rain forest?
10. Sketch a diagram illustrating what you think a tropical rain forest would look like from ground level to tree top.
11. What parts of the world contain tropical rain forest?
12. What does the word humidity mean?

CONIFEROUS FOREST

The trees of the coniferous forest are mostly cone bearing evergreens. Spruces and firs are the most common of the evergreens. Coniferous forests frequently live in areas where weather is too severe and soil conditions are too poor for deciduous trees. Windy sea coasts, mountain slopes, thin and sandy soil, far north areas, and glacier areas are typical coniferous forest areas. In North America the coniferous forest covers most of Canada, parts of New England and Alaska, and the areas along mountain slopes.

Summer growing seasons in most of the coniferous forest areas are short followed by a long cold winter during which the ground is covered with snow. The rainfall mostly occurs during the summer and varies from 15 to 40 inches per year. The shape of the evergreen trees helps them withstand the heavy snow that piles up during the winter season.

Our western coast supports an unusual type of coniferous forest, the redwoods. These trees are the tallest in the world and depend on the fog from the Pacific coast for water during the dry summers.

In contrast to the redwood forest is the coniferous forest of the far north known as taiga. The taiga consists of much smaller spruce and fir trees that are suited to survive in the Northern hemisphere south of the tundra. In addition to the spruce and fir the aspen, willow, alder, birch, and poplar trees are also found. All of these trees are able to grow during the short summer and then survive the extreme cold and snowy winters. During the short summer growing season the ground is covered with thick growth of mosses, lichens, bushes and other small plants. Many areas develop into swamp-like pools resulting from the melting snow and rainfall. These swamps support a large number of swamp plants.

The coniferous forest has a unique set of animals just like any other area. The animals will vary from one coniferous forest to another, but they all will have some animals like the crossbills that eat seeds from cones. Each one will have a grazing or browsing animal like the moose; a group of rodents such as mice and voles that eat twigs, bark, roots, seeds; a variety of insects that eat the plants; tree cutters like the beaver; small mammals like rabbits; and larger predators such as foxes and hawks.

Decay of dead logs and fallen tree needles is a rather slow process in the coniferous forest. This is because the mold, bacteria, and other decomposers do not work very fast during the long cold winters.

Lodgepole pine, pitch pine, jackpine, and knobcone pine all require fire to open their cones and free their seeds. After a fire has burned over a coniferous forest the newly freed seeds of these trees are ready to start growing. This is one of nature's ways to recover the coniferous forest after it has been damaged or destroyed by fire.

The coniferous forest provides us with most of our lumber and pulp for paper. In addition, the coniferous forest areas act as storage areas for water by collecting snow during the winter and then feeding the streams and rivers as it melts in the summer.

Questions and Activities

1. What climate is associated with the coniferous forest?
2. What are some ways our daily lives are affected by the coniferous forest?
3. How would you describe the typical soil of a coniferous forest?
4. How does the shape and structure of an evergreen tree help it stand up under heavy snows?
5. Where are coniferous forests located over the world?
6. What is the most important producer in the coniferous forest?
7. How can fire help some types of evergreens?
8. Use reference books to make diagrams illustrating various types of evergreen leaves and cones.
9. Diagram three food chains you would expect to find in a coniferous forest.
10. Why does dead material decay slowly in the coniferous forest?
11. Using library reference find out if there are male and female pine cones. If so, how are they different?
12. Examine a pine cone carefully and see if it contains any seeds.

CHAPARRAL

The Vagueros that herded cattle over the hills of southern California wore leather leggings called "chaps", to protect themselves from the thick thorny shrubs, trees, and bushes. The scrub oak that caused the most trouble was called chaparro. The chaparral is the pygmy of forests with trees seldom growing more than twenty feet high. Most of the chaparral plants have small thick, leathery, dull green leaves that help prevent water loss. Plants in the area have very deep roots that are able to reach water supplies and store the water.

The chaparral has two seasons rather than the normal four. From April to November there is a long, dry, hot, windy season followed by a moist, cool winter season. The moderate rainfall occurs during the winter season. During the winter most days are mild and sunny, due to the breezes from the ocean. This area is sometimes described as being semiarid. Plants in most areas grow during their summer season. Not so in the chaparral. The chaparral plants mostly lose their leaves and go dormant during the hot dry summer. Then during the cooler and moist winter, the trees as well as the wildflowers, shrubs, grasses, and other plants green up and grow rapidly reproducing themselves.

Few of the chaparral plants are of value to modern society. Some of the early natives used the plants for food, medicine, and tools. The oak acorns were ground into morteros, the yerba santa or "sacred plant" was used in making a sore throat and lung ailment remedy, and squambush was woven into baskets.

Even though the chaparral does not appear very inviting, many animals make their homes and find food in the area. Many reptiles, snakes, and lizards live among the thick ground cover along with numerous mice and other rodents. Birds, deer, coyotes, bobcat, rabbits, wood rats, and ground squirrel find food and shelter in the chaparral.

Areas similar, but different than the chaparral of southern California, can be found in Australia, southern Europe, west coast of Chile, and southern Africa. Today much of the chaparral has been developed by housing, industry, and agriculture.

Questions and Activities

1. What climate is associated with the chaparral forest?
2. When do you think people living in the chaparral need to be most concerned about forest fires?
3. Why is the chaparral sometimes called the pygmy of forests?
4. What advantage is it to have thick leathery leaves?
5. How was the chaparral used by the natives of southern California?
6. Why do the trees in the chaparral seldom grow more than 20 feet high?
7. How does the dormant period in the chaparral differ from the dormant period for trees in Kansas?
8. What is happening to the chaparral today?

GRASSLAND

At one time forty percent of the earth's land was covered with a variety of grasses. Today, much of this grassland has been changed into farmers' fields. Some of the former grassland area has been so poorly managed since it was first plowed that today it is highly eroded or has become a desert.

The grasses range in size from the big bluestem standing over six feet high to the buffalo grass which is only a few inches tall. Natural grasslands are composed of wildflowers, other forbes, and a mixture of grasses, not a single type of grass.

Grasses are unable to compete with trees in the parts of the world favorable to trees. Therefore, grass will be found mostly in areas where trees have difficulty growing. These areas will usually have between twenty to thirty inches of rainfall each year and it will mostly occur during the spring or early summer. Before settlers moved into the grassland, fires started by Indians and/or lightning would burn the grassland. These fires would kill any little trees that had started growing in the grass, but would only burn off the top of the grass. This helped grass to survive in the area where trees and grassland met.

The early pioneers called the grassland of central United States the Great American desert. These first pioneers did not understand how to farm the grassland and were interested in land where there were trees. Once the sod plow, which was able to cut through the thick and matted grass roots, was developed, the grassland's riches were understood. The rich fertile, black soil which had been raising native grasses was planted to food producing grasses such as corn, wheat, and oats. Much of the richness of this soil resulted from the decaying of dead grass returning minerals to the soil. The small amount of rain did not wash the minerals away as it does in areas where rainfall is high.

The settlers and other people moving into the grassland caused great changes. The bison or buffalo which was the most important and common animal of the grassland was killed for the hides. Cattle and sheep were introduced to replace the buffalo as the large grazing animals. The Indians were driven from the grasslands as they no longer could survive without the buffalo which was their prime source of food, material and clothing.

Without the grasses to cover and protect the soil, great amounts of soil were washed into the rivers by the rain. Hot dry summer winds also were able to blow the unprotected soil. Other grassland areas have given way to highways, cities, and industry. Much of the remaining grasslands in Africa and United States are being overgrazed by domestic animals. This overgrazing removes the plants and packs the soil causing the grassland to turn into desert like area.

The native grasslands had their own unique set of animals. In the United States grassland the largest of these animals were the bison and antelope which grazed over large areas. Other grassland animals include prairie chicken, ground squirrel, prairie dog, insects, burrowing owl, ferrets, badgers, coyotes, moles, hawks and snakes. The grazing grassland animals have excellent long distance vision and strong legs and feet for running. The grassland animals that could not adjust to living in the man made world exist today only in isolated areas or have become extinct.

Man did not realize how he was destroying the grasslands until it was too late to save some areas. Northern Mongolia was once a rich fertile grassland. Overgrazing by sheep has caused the area to become a deserted wasteland. The dust bowl of the twenties and thirties nearly turned the middle United States into a similarly useless area. To prevent further destruction and loss of soil in Kansas and surrounding states, the government started various soil conservation practices. These practices included strip cropping, contour farming, using cover crops, limited grazing, stopping the farming of steep hillsides, terraces, and planting of shelter belts. These soil conservation practices have greatly sloved down the loss of soil and allowed us to use the land that was once grassland for producing food.

Questions and Activities

1. What kind of climate must there be in order to have a grassland?

2. How do fires help grasslands?

3. What kind of plants produce food in a grassland?

4. Why was there little erosion in the grassland before the settlers?

5. Diagram five different food chains you would expect to find in a grassland.

6. What kind of plants did man plant in place of the native grasses?

7. What would happen to a house built from Kansas sod today?

8. Compare the ways the Indians used the grassland with the way the settlers used the grassland.

9. There are three major types of grassland: steppes, prairies, and savannas. Do research to find out how each of these types of grassland varies.

10. Do research to find out how the African grassland animals differ from American grassland animals.

11. What animals did man introduce into the grassland in place of the native species?

12. Why is man ploving up the native grasses and replacing them with other plants?

13. Is there any value in protecting native grassland and the animals that were originally on it?

14. Describe some of the ways man now protects the soil while farming it.

15. Why is the grassland soil some of the richest in the world?

16. To find out what one organization is doing to help protect native grassland, contact the Save The Tallgrass Prairies, Inc., Box 453, Emporia, Kansas, 66801.

17. Dig up some samples of various types of grassplants. Compare their roots, stems, leaves, and seeds. Make diagrams illustrating the similarities and variations.

TUNDRA

Just below the Northern ice cap is the tundra area which has a very different climate and plant and animal life. The summer days are long, but seldom warm to over 40° F. The winter days are very short and get as cold as 10° F. The soil is completely frozen during the winter and only thaws out a few inches down during the summer. The long summer days, short winter days and low temperatures are the result of the location on the earth of the tundra area in relationship to the sun.

The summer only last about eight weeks and is followed by an abrupt change to winter conditions. During this short tundra summer, plant and animal life is plentiful. Although the yearly rainfall is less than six inches, the tundra in the summer becomes a swamp-like region with small ponds everywhere. The ponds result from the melting snow and ice on the surface. The ground below is frozen and will not allow the water to soak into the soil, so it forms swampy areas.

Grasses, sedges, lichens, and mosses are the typical tundra plants. A few woody trees only a few inches tall are present. All of these plants that live and reproduce in the tundra have the ability to grow, produce flowers and seeds, and complete their yearly growth in the very short summer season.

Most of the tundra animals do not live the year round in the tundra, but migrate in during the summer and leave during the winter. During the summer, these animals are found: caribou, ptarmigan, artic fox, insects, snowshoe hare, lemming, owls, weasels, and numerous other animals. The few animals that do not leave the tundra during the winter hibernate underground, live in burrows and eat plant roots, or, like insects, survive in the form of eggs.

There is not a tundra area in the southern hemisphere because the area that would be in the right climate location is covered by the ocean.

Questions and Activities

1. Describe the climate in the tundra area.
2. Make dravings illustrating why the tundra days in the summer are long and days in the winter are short.
3. Use the library to learn how people survive and live in the tundra area.
4. Find out how the word permafrost is related to the tundra.
5. What kind of problems does the tundra of Alaska create in building the Alaskan oil line?
6. Why is there no tundra around the Antarctic?
7. How would you generally describe the tundra plants?
8. What kind of life do most tundra animals have?
9. Why does the water collect in ponds in the tundra during the summer?
10. Can you find any tundra-like plants in the middle of the United States?

DESERT

One seventh of the earth is desert. Deserts are areas with little rainfall, high daytime temperatures, low nighttime temperatures, and tough plants and animals that are able to live and reproduce in an extremely hot and dry environment.

Most of the world deserts are along either the Tropic of Cancer or Tropic of Capricorn. The primary cause of deserts in these areas is the dry winds. Some of the deserts result from mountains removing the water from winds as they rise over the mountains. Rainfall varies from ten inches to less than one inch during the year in some desert areas. Since there is very little water in the air over desert areas, the sun's heat pours directly onto the desert soil during the day causing temperatures of 120° F. to be common. At night the heat from the earth is quickly lost because there is no blanket of moisture to capture it. Most deserts do have definite winter and summer seasons. The winter season tends to be the wettest and coolest. The climate varies with the location of the deserts, but each desert tends to have a short period of time when it has greater rainfall. During this period rapid growth and reproduction of plants and animals occurs.

Minerals in the desert soil are not washed away as in other climates. As a result, many minerals are found on the surface. Some of these minerals are helpful for plant growth, while others can kill plants. The Imperial Valley of California is a desert area where the minerals present cause great plant growth when the land is irrigated. On the other hand, the Atacama desert in Chile contains so much salt no plants will grow.

Desert plants have developed three different ways to survive in their environment. Many seeds from grasses, herbs, and weeds do not grow until after a large rainfall. Then they grow rapidly reproducing before the water evaporates. Shrubs like the creosote bush have roots that spread over wide areas to collect surface water and roots that grow deep to reach water below the surface. The cactus which has only shallow roots collects water and stores it in its spongy stem. As the cactus uses the water during dry periods, the stem becomes smaller. Nearly all desert plants have few or no plants surrounding them, small or no leaves, and waxy covered stems and leaves to help conserve water.

A variety of animals, reptiles, insects, birds, and mammals can be found in deserts. Few of these animals are visible during the day; most of them are nocturnal and search for food and shelter from the sun during the night. Desert animals include plant eating insects, lizards, snakes, seed eating birds like quail, insect eating birds like flycatchers, ground squirrels, rabbits, mice, bats, owls, and coyotes.

The location of plant and animal life on the desert is related to the water supply. The more water present the more plants and animals present. Man is gradually learning ways to bring water into the desert areas of the world. This allows many of the desert people that used to lead nomadic lives to settle down and become farmers.

Questions and Activities

1. What climatic conditions are associated with desert areas?
2. Do you think dead plants and animals will decay very fast in the deserts? Why?
3. Why are most desert animals nocturnal?
4. Where are most deserts located in the world?
5. Why do many deserts grow excellent crops when they are irrigated?
6. Describe three ways plants are adapted to survive in the deserts.
7. Why does the temperature change greatly between day and night in the deserts?
8. Diagram a food chain that could be found in a desert area.
9. Why is water important?
10. Using library reference find out how man changed the "Fertile Cresent" valley along the Tigris and Euphrates into a desert.
11. Using library reference, find out about life in the Sahara.
12. Find out how desert sand dunes are formed and make drawings illustrating the various types.

WATER

Nearly three-fourths of the world is covered by water. This water forms small puddles, ponds, large lakes and, of course, the oceans. The type of water varies from fresh well water to extremely salty water. The bodies of water differ in that some stand still while others are rapidly moving in streams and rivers. These different characteristics and others cause each body of water to contain and support different types of plants and animals.

Regardless of what type of water one is discussing, the most important food producing plant present in any water is algae. Algae is the microscopic green plant that often causes water to appear green or in some cases red. When large amounts of algae are growing together it will often appear slimy and stringy. Algae provides most of the primary food source for water animals. It also is responsible for about eighty percent of our oxygen supply. Just like green land plants, algae uses carbon dioxide and releases oxygen, which is needed by animals. However, land plants vary greatly in size and type from the water plants such as algae.

A closer examination of life in the oceans will provide a fairly typical view of life in water. The oceans can be divided into three different areas: 1) the coastlines and estuaries; 2) open spaces between shorelines; and 3) scattered locations where upwellings occur. The upwellings result from water moving along the ocean bottom until it runs into an under sea ridge that causes the water to carry bottom material to the surface.

The ocean shoreline and estuaries, which indlude about ten percent of the ocean, are characterized by constantly changing water level and the mixing of fresh and salt water. In addition to the algae that moves with the changing water level, one finds many other hardy plants. These shallow water plants have strong roots and the ability to withstand the beating of waves, alternate drying and being submerged, temperature changes, and salinity changes. These plants extend out only a few miles into the ocean until the depth will no longer provide sufficient light for them to survive. The fresh water constantly entering this area brings the various minerals needed by the plants. These plants in turn not only provide a source of food but also provide an area in which the animals can find protection for nesting and rearing young. Nearly one-half of the life in the oceans is found in the estuaries and along the shorelines.

It is from the estuaries and shoreline areas that we obtain many of the ocean fish, oysters, lobsters, and other sea foods we eat. These are also the areas of the ocean where we are destroying the plants and animals by dumping our garbage, waste chemicals, and other pollutants. Tuna and oysters living in some of these areas are not safe to eat because they contain dangerous amounts of chemicals such as mercury.

Upwelling areas which make up only 0.1 percent of the ocean are very rich in algae. This rich growth is encouraged by the abundance of minerals brought up from the ocean floor to the surface. The algae growth provides the beginning for many food chains consisting of a great variety of animals from the microscopic animals to large whales. Nearly all of the ocean life not found in the estuary and shoreline areas exist around the upwellings.

The open spaces of the oceans include nearly 90 percent of the total ocean area. Yet, less than one percent of the life in oceans is found in these open areas. The minerals needed for algae growth are very limited; thus, little algae or other organisms that use algae for food can exist. Other factors that limit plant and animal growth are 1) lack of protective areas for rearing young; 2) light that is needed for green plants penetrates only a few feet into the water's surface; and 3) the water is not stirred sufficiently to contain an adequate supply of oxygen. These factors are important to keep in mind when one hears talk about man turning to the oceans for food. These large open spaces making up most of the oceans are no better producers of food than deserts and mountain tops.

Most rivers, lakes, and ponds do not have the large open type space found in the oceans. Their plant and animal life is more evenly distributed with the heaviest concentrations near the shoreline.

Questions and Activities

1. How much of our earth is covered by water?
2. What is the most important green plant living in water?
3. Why is algae considered a very important green plant?
4. What are the three major divisions of the oceans?
5. What areas of the oceans contain the most life?
6. What are some examples of food we get from the oceans?
7. What part of the oceans produce these animals?
8. Which part of the oceans are being affected by our pollution?
9. What must be present in water if algae is to grow in any abundance?
10. Sketch a cross section of an ocean showing the various types of areas.
11. Diagram some food chains found in water.
12. What does the word upwelling mean?
13. Collect samples of algae and view them with a microprojector.

APPENDIX D

Short Stories

The short stories included in this Appendix are intended to illustrate and expand various activities in this unit. Most of the stories are followed by questions that can be used to direct a follow-up discussion.

A Story of Tears and Kisses. . . . . D- 2
One legend explaining the origin of our using mistletoe at Christmas.
Plants From the Land of Milk and Honey . . . . . D- 4
Discussion of the plants referred to in the Bible.
Plants of the Holiday Seasons. . . . . D- 6
Includes a short description of many commonly used Christmas plants
The Green Revolution - Is It Losing Its Glow D-10
The hopes and problems associated with trying to solve our world food problems.
Plants That Eat Animals. D-14
A description of carnivorous plants, how they operate, and where they are found.
Plant Galls: Host and Parasites D-15
An explanation of the origin of plant galls.
Plants Have a Few Tricks, Too. D-16
Illustrates some of the ways plants defend themselves.
Yes - There Are Endangered Plants. D-18
Explains the causes and some of man's efforts to save plant species that are in danger of becoming extinct.
The Amazon Jungle - Fragile Giant. D-21
The ecological balance of the tropical rain forest and man's influence on this balance.
Baobab - The Upside-Down "Tree of Life". D-24
Describes the ecological importance of the baobab tree in Africa.
When Plants "Munch" Metals D-27
Illustrates how plant mutations allow new plant varieties to develop and survive in areas disrupted by man.
The Battle Over Wilderness D-30
The origin of natural parks, and the conflicting use of them as advocated by various groups.
Parks Vs. People D-35
The ecological deterioration resulting from over use of parks by people.
Garlic - Herb That Kills Insects D-38
The process by which a safe insecticide can be made from plants.
First-Aid For Sick Trees D-40
Description of common health problems associated with yard trees and ways to treat or obtain the proper treatment for the trees.
Dutch Elm Disease - On the Scent of a Cure D-43
The problem, causes, and research relating to Dutch elm disease.
Oh! What a Garden!. D-46
A verbal pictoral description of plant groups in various parts of the world.
The Story of Corn. D-47
Traces the importance of corn from its use by the early Indians to the present.
Plants Help Control Pollution. D-51

A STORY OF TEARS AND KISSES*

Today many of our rituals are carried on without awareness of their origins. The following article by David Strohm presents one of the legends that explains the origin of kissing under the mistletoe.

According to ancient Norse legends, there once lived in the sliver lining of the heavenly clouds a god known as Balder - god of sun, heat, and summer. Balder was extremely popular among the other gods and creatures of the universe because of the delight which they all felt basking in the warm summer sun. He didn't have an enemy in the world.

But then he began to experience frightful dreams in which his life was being threatened by some mysterious force. He spoke of these to the rest of the gods, that they might protect him from his unknown enemy. The gods discussed these premonitions and Frigg, mother of Balder, announced that she would exact an oath from every creature and substance in the universe that they would not harm Balder.

And so she set out to the valleys, the hills, the skies and the sea; robins, raccoons and sharks, fire, water, stone, earth, and metal all promised that they would not harm her son. Her tedious chore finished, she returned to the heavens, exhausted but happy knowing that her son was safe. The gods rejoiced at the news and it came to be great fun for the gods to gather around Balder and bombard him with lances and spears - knowing that he was invincible to them all.

One day Loki, a mischievous evil god, disguised as an old woman, went to see Frigg.

"And what are the gods doing today?" he asked in a wispy voice.

"They are amusing themselves by throwing objects at my son, Balder," she replied. "Neither weapons nor words will ever wound him for I have received a sworn oath from every worldly thing that it will cause no harm."

"Is there nothing at all you have not approached?" questioned Loki.

"Nothing," said Frigg, "though there is one young sprout, the mistletoe, in a wood over to the west of Valhalla far too immature to swear oath."

Hearing this, Loki smiled with delight and whisked over to Valhalla to harvest the little sprouts. He soon returned to sounds of mirth and laughter resounding from the gods as they pelted Balder with spears of metal, wood and stone only to have them fall harmlessly at his feet. Loki sought out Hodor, the blind god, in the crowd and asked why he wasn't joining in the festivities.

"Because I am blind and cannot see Balder to throw at him," Hodor replied. "Besides I have nothing to throw."

Loki quickly bound the sprouts of mistletoe into a sharp spear and placed it in Hodor's hands.

"Here is a spear. I shall point you toward Balder and you too can partake in the fun."

*Reference: National Wildlife, Dec. - Jan. 1973, Page 28, by David Strohm

The blind man drew back the mistletoe and flung it into the back of Balder. The sun god grimaced in pain and tumbled lifelessly down to Hel, god of the underground. The gods shrieked in disbelief; when Hodor learned of his folly he cried in anguish. But the greatest pain of all was experienced by Frigg.

"Let us mourn this dreadful deed," she cried. "Let all the universe shed tears for Balder that he may escape Hel." One by one she approached all the elements to ask for sorrow: and this time she did not forget the mistletoe.

With a booming clap of thunder the skies let loose a downpour of rain to protest the capture of the sun god; the tiniest creatures of the world shed a tear in memory of the god of summer; and moisture seeped from every metal at the passing of warmth to cold. (Haven't you noticed the wetness on metal when brought from heat to cold?)

And the mistletoe sorrowfully wept tiny white berries.

Because of the universal sorrow, Hel released Balder from below so he could continue to bring sun to the universe. Frigg was so overjoyed that she kissed everyone beneath the approving gaze of the mistletoe plant.

And to this very day, people around the world celebrate the most joyous season of all by sharing a kiss under the white berries of the mistletoe.

Questions and Activities

1. According to the legend what would the world be like if all the elements had not expressed their sorrow for Balder?
2. Who was Balder's mother?
3. What was Balder the god of?
4. Why did Balder want an oath not to hurt him from every creature and substance of the earth?
5. Why did Frigg not get the oath from the mistletoe?
6. Who was the bad god that wanted to harm Balder?
7. Which god threw the mistletoe spear into Balder?
8. What happened to Balder when he was hit with the mistletoe spear?
9. What caused the mistletoe berries to be formed?
10. How did the custom of sharing a kiss under the mistletoe get started according to this legend?

PLANTS FROM THE LAND OF MILK AND HONEY*

Plants have always been important to man as a source of food, shelter materials, and pleasure. The following article by John Asch provides some insight into how the people of Biblical times utilized plants from their environment. The December - January issue of National Wildlife contains colored illustrations of many of the plants named.

How did the holy land look in the days of Abraham and Moses? How did people live? What did they eat? These are just a few of the questions that can be answered by studying the plants mentioned in the Bible.

The trees mentioned in the Old Testament played a major part in the lives of the people of the Holy Land. The Cedar of Lebanon was known as the "Prince of Trees" - a symbol of strength and grandeur. Its wood is so rot resistant and durable that these trees were cut in great quantities to construct Solomon's "House of Cedar."

Most prestigious of the Biblical trees is the olive tree - symbol of peace. With crooked trunk and spreading foliage, the tree characterizes the Mediterranean landscape. Besides food, the olive supplied oil for lamps, and was used in soaps, cosmetics, and medicine.

The acacia tree was the most versatile tree in Biblical times. The Ark of the Covenant and the Altar of the Tabernacle were made from its wood. The yellow flowers were used for perfumery and pods yielded feed and food. The druy catechu was extracted from its heartwood and the bark was used to tan leather.

There are many references to flowers in the Bible but the names do not always coincide with flowers so named today. The Hebrew shushan, for example, is translated to be the "lily," but most botanists agree that it was actually the anemone or windflower. The "lily of the valley" is thought to be the beautiful blue hyacinth.

The "rose" in the Bible is probably the narcissus in some passages, and the oleander in others. The "rose of Sharon" refers to the tulip. The bulbs of the "Dove's Dung," known today as the Star-of-Bethlehem, were used as food during famines. "Tirzah," found in the Song of Solomon, is now known to be the crocus.

For cooking, people of the Biblical lands relied on trees and herbs. Aromatic coriander leaves flavored soups and wines, while the seeds of coriander and cumin made condiments. The most common "bitter herbs" were watercress, chicory, dandelion, endive, and sorrel. Marjoram is thought to be the "hyssop" which was used in cleansing lepers.

Of all the ceremonial plants, frankincense and myrrh, the gifts to the baby Jesus, are most familiar. Frankincense came from the tree Boswellia carterii. Its bitter gum was used in sacrificial rites of the tabernacle and temple. Myrrh is a gum from Cistus villosus, a thorny shrub from East Africa whose wood and bark are strongly scented. It was used in embalming, burned as incense, and was a necessary ingredient of holy oil.

*Reference: National Wildlife, Dec. - Jan. 1973, Page 20, by John Asch.

The grapevine is the first cultivated plant mentioned in the Bible. Wild grapes supplied fresh fruit, wine, raisins, and vinegar. The common fig is the first tree mentioned in the Bible -" ... and they sewed fig leaves together and made themselves aprons" (Genesis 3:7). The fig tree grows everywhere in the Middle East among rocks, ruins, and terraces. Besides fruit, the small spreading tree provided welcome shade and was a symbol of tranquility: "... And Judah and Israel dwelt safely every man under his vine and under his fig tree." (I Kings 4:25).

Life was semi-nomadic in early Biblical times and people gathered olives, dates, walnuts, and figs. But when they began to form villages, they grew barley, wheat, sorghum, flax, grapes, and vegetables. We read of Isaac sowing, Joseph binding sheaves, and Reuben in the harvest field. The Biblical people truly "lived off the land."

Questions and Activities

1. What did the article mean when it said the people truly "lived off the land"?
2. Why is there doubt about which plants the Bible is referring to sometimes?
3. What is an herb?
4. What is frankincense and where is it from?
5. What is myrrh and how is it used?
6. What were the first plants cultivated by the Biblical people?
7. Use library books to find out how we are using the Biblical plants today.
8. In what part of the world did the Biblical people live?

PLANTS OF THE HOLIDAY SEASONS*

Introduction

Lights and fires are symbols of warmth and lasting life. Evergreens are symbols of survival. There are many interesting legends of holiday customs and uses of plants in holiday celebrations, often dating back to pagan celebrations. Christmas as a Christian festival has only been celebrated since about 500 A.D. Early churches established the festival in the civilized world and presumably brought some of the pagan trappings and superstitions along with it. Mistletoe, ivy, and yew may have been plants associated with these early celebrations.

Perhaps you have been making arrangements for your tree or you are about to help shop for this important pruchase of the season. What kind of Christmas tree do you have or will you purchase?

Nearly all of our popular Christmas trees and greenery are evergreen trees and shrubs. That is, they have leaves which remain on the plants during the entire year. The plants do lose old leaves and develop new ones; however, the leaves fall over a long period of time and the trees are never completely leafless as are deciduous trees.

Most of the Christmas trees are coniferous, i.e., conebearing. Many coniferous trees must be several years old before they bear cones, and since many of our holiday trees are young trees, they generally do not possess cones. Most of the trees are native to the North American continent. Certain trees have been selected, cultivated, hybridized, and planted in gardens for many years, thus making many species and varieties of each of the groups of trees available.

JUNIPER

The only native conifer of our state of recent times is the red cedar or juniper so these probably were the first trees used in Kansas as Christmas trees by pioneer children. These are still used by some families.

The junipers may be tall and pyramidal in habit or bushy and spreading shrubs. The branches bear a dense growth of sharp-pointed, awl-shaped leaves, and closely overlapping scale-like leaves flattened against twigs. There are two types of juniper plants - (1) males: those which bear pollen-producing cones, and (2) females: those which bear seed-producing cones. If you are familiar with cedar you may be surprised to know that the blue "berries" are actually cones. Section one of these cones. How many seeds did you find?

FIR

Our most popular Christmas tree is the fir. This is a native North American tree with species widespread over the continent, especially in cool climates of high altitudes and latitudes. The fir tree is triangle in shape with regular layers of branches. Firs, as do most conifers, produce both pollen cones and seed bearing cones on the same tree. The cones are 5-12 cm high and grow upright on the branches. When the needlelike leaves fall from the stem, the twig is smooth to the touch.

*Condensed from "Plants of the Holiday Seasons," The Naturalist, Volume 15, No. 2, December 1968.

HEMLOCK AND SPRUCE

Other trees sometimes selected as Christmas trees include the hemlock and spruce. Both are triangle-shaped trees with dense limbs. The spruce is native to mountainous regions of North America, while the hemlock, perhaps the most beautiful and graceful of all conifers, is native to the eastern and northeastern states and the higher altitudes of our western states. The hemlock, incidentally, is not poisonous. (Poison "hemlock" is an herb related to the carrot.) These two trees are so similar in appearance that even experienced botanists often have difficulty distinguishing between the two. Both have rough leaf bases when the needle shaped leaves are removed. The hemlock leaves have short stems on the leaves and rectangular shaped flattened needles, whereas those of spruce are without the distinct petioles and the needlelike leaves are usually square.

PINE

Pine (Pinus) trees are lovely triangle trees with long needle shaped leaves and a strong odor. The leaves grow in clusters or bundles enclosed within scales. The female seed bearing cones occur near the ends of the upper branches with the male pollen cones occuring on the lower branches of the same tree. These cones, often colorful shades of red or yellow, appear in winter or early spring. The pollen is shed from the male cones and if pollination by wind occurs, the scales of the small burrlike ovulate cones close. The small pollen cones then fall from the trees. Later fertilization occurs and the winged seeds and woody cones develop. The seeds are enclosed on the scales of the woody cones. When the cones and seeds have matured, the scales of the cones usually pull apart; that is, the cones open and the seeds fall. The winged seeds may be carried by the wind to new locations. The time required for the seeds and cones to develop may be two or three years or even more in some species.

DOUGLAS FIR

The Douglas fir, a native of the Rocky Mountains and Pacific coast, is prized as a Christmas tree in some areas. The tree is somewhat of a puzzle for it resembles the spruce and fir as well as the hemlock and yew. The flattened, slightly pointed needles are 2 to 4 cm long and grow around the branch to give a fully rounded appearance. The leaves are grooved on the upper surface with a white band on each side of a midrib. Leaves, when pulled from branches, leave an oval scar on top of a short projection. The trees have soft needles in comparison with other coniferous trees. They can be identified by the many scaled, long (7mm), end cones with side buds. The needles remain on the tree for a considerable period of time after the trees are cut so these are favored by many persons in tree selection.

YEW

Another coniferous plant used as holiday greenery may be the yew. These plants have a dense, dark green foliage, the darkest green of all evergreens. The leaves are, 1 - 2 cm long and 2 - 4 mm wide, dark green above and much paler on the underside. They are attached to the stem by a slender yellow stem about 2 mm long and grow on opposite sides of the stem. Yew plants may be either trees or shrubs and are often trimmed in hedges or topiary work. As in the junipers there are two types of plants: the male pollen-producing ones and the female seed-producing ones. The bright red, fleshy, berrylike fruits which ripen in autumn are conspicuous against the dark green foliage and are sought by many birds.

ARBORVITAE

Arborvitae occur as native plants in northeastern and northwestern states and are used in many areas in landscape plantings. The plants have glossy bright green overlapping rows of small scalelike leaves that form flat lacy branches. The urn shaped brown cones containing few seeds grow in an upright position near the ends of the twigs.

These are some of the most commonly used coniferous plants, but there may be others with which you are familiar.

POINSETTIA

The poinsettia is one of our most colorful and conspicuous holiday plants. If you have a plant available, examine the flowering branches carefully, preferably with a hand lens. Can you locate the real flowers? The brightly colored red, white, or pink structures are colored leaves and really not petals as we commonly assume. The flowers are the clusters of small yellowish structures surrounded by the colorful leaves. There are two types of flowers, the male which produces the pollen and the female which produces the egg and develops into the fruit and seeds. A gland located along the edges of the clusters, secretes a sugary fluid which probably serves to attract insects which would carry pollen from one plant to another.

Poinsettia plants are commonly cultivated in greenhouses and in out-of-door gardens in Florida and Southern California, but are native to Central America and Mexico. The plant is named for Dr. Joel Poinsett who introduced it into cultivation.

It is not an accident or chance happening that all of the poinsettias bloom during the holiday season. Actually, horticulturalists plan carefully weeks in advance to place the plants in favorable conditions to cause flowering during the last days of December. The temperature and the length of the light and dark periods, are two factors which must be carefully regulated to produce flowers at the proper time for the market.

HOLLY

The bright red berries and glossy green spiny leaves of holly are associated with the holiday season by many persons. Holly, a native of eastern and southeastern states, grows as a tree or shrub and is often planted as an ornamental. The thick leathery leaves are from 5-10 cm long and 2.5-5 cm wide. The leaves remain on the American holly tree for three years and then are shed in the spring; thus, this tree, too, is essentially an evergreen. The flowers on both the male and female trees are small. Only the male trees produce the conspicuous berries which are sought by both men and birds.

It has been a custom of great antiquity, even from Roman times, of hanging the interior of dwellings with evergreens, including holly, as a refuge for sylvan spirits from inclement winter weather.

MISTLETOE

Mistletoe is another interesting plant used during the holiday season. The unusual yellow-green color of the leaves and transluscent white berries make this an important plant, particularly during the holidays. The berries which ripen in the winter are formed from small petalless flowers. In addition, this is one of the few green seed plants of the United States which lives as a parasite. It is common as a shrub in the branches of many trees in the southern and eastern states. Seeds, often deposited by birds, germinate on the bark of the trees. The new roots, which grow quickly into the living wood of the host tree, absorb water and minerals. The leaves contain chlorophyll; thus the plants are able to produce their own food.

Perhaps because of the parasitic growth habit, or perhaps because of the spectacular appearance of the plant in leafless deciduous trees in winter, or because of the rather striking appearance of the fruits, many superstitiions and legends have developed around the mistletoe.

In England there is a legend that the mistletoe was once a large and beautiful forest tree. The wood of this tree was chosen, according to this legend, to be used for the construction of the cross upon which Christ was crucified. Because of this the mistletoe was condemned to be a parasite forever. Some pagan peoples believed mistletoe to be a charm against all types of evils and ailments. Others believed it to be an emblem of good fortune and happiness.

CLUB MOSS

One of the non-seed plants often utilized in wreaths and table decorations is the club moss or princess pine. This is a plant which grows in moist shaded woodlands of our northern and eastern states. The plants are not pines; in fact, they are not even woody plants, but small green plants seldom over 20 cm tall. They possess small leaves and conelike caps with spores. They are attractive plants, particularly when dyed and dried. Decorations constructed of these plants often are stored and used for many years.

NORFOLK ISLAND PINE

The lovely Norfolk Island Pine from the South Pacific is used by some as a decorative plant during the holiday season. This is a picturesque triangle shaped tree with layered branches and soft bright to dark-green leaves. It is widely grown in greenhouses and as a potted plant in homes. In warm parts of the country these trees are grown out-of-doors in gardens and yards to produce an unusual and unique effect.

CHRISTMAS CACTUS

The Christmas cactus, a member of the cactus family, often blooms in December. The plant produces small glossy green leaflike jointed stems with blunt ends and flowers of brilliant shades of red to purple.

THE GREEN REVOLUTION - IS IT LOSING ITS GLOW?*

In many parts of the world, children never play. They have neither enough energy nor enough interest for such activities. Why?

They're slowly starving! So are their parents.

Half the world's people are hungry most of the time. Thousands starve to death. Millions are stunted by malnutrition. As more food is produced, more people are born to compete for it. Each and every day, the problem worsens.

What can be done about it?

There are two basic ways to tackle the problem. One way is to slow the rate at which the world's population is increasing. However, present attempts to do that aren't working very well.

The second way is to greatly increase the world's supply of food. This approach is actually scoring some successes.

During the past 25 years, scientists have searched for ways to increase food production substantially in poorer countries. Some scientists focused on developing cheap sources of protein. Others tried to introduce modern farming methods in place of old, inefficient methods. Still others zeroed in on developing high-yield grains to produce record crops even under unfavorable conditions.

All three of these approaches have been somewhat successful. But the "new grain" approach has been by far the most successful. New varieties of wheat, corn, rice, millet, and sorghum are now providing rich harvests in lands where previous harvests were always poor. This great change from poor to rich harvests is known as the "Green Revolution."

The first seeds of this peaceful revolution were sown in 1944. In that year, the Rockefeller Foundation sent a young agronomist (specialist in field crops) named Norman Borlaug to Mexico. Dr. Borlaug's mission? Free Mexico from the need to import wheat!

To do this, Dr. Borlaug searched for a strain (variety) of wheat that would survive drought, resist disease and pests, and flourish in Mexico's soil.

The search was difficult. There are thousands of different strains of wheat in the world. Each type varies in size, yield per acre, blight resistance, moisture needs, growing period, soil requirements, and various other factors.

Some strains looked promising. But none completely satisfied Dr. Borlaug. Therefore, he decided to create new strains that would have as many advantages and as few disadvantages as possible for use in Mexico. Let's see how he went about this.

Normally, wheat is self-pollinating. That is, the anther (male element) and stigma (part of the female element) of a grain of wheat are housed in a single structure - the floret (sex organ). As a result, pollen (a dust made up of tiny reproductive bodies) passes directly from the anther to the stigma of the same wheat grain. This is very different from cross-pollination, in which the pollen moves through the air from the anther of one plant to the stigma of another plant of the same species.

*Reprinted from Science World, Pages 5 - 8, December 14, 1970.

Since Dr. Borlaug wished to combine certain features of different strains of wheat, he had to force cross-pollination. He did this by opening florets (there are about 50 florets in a typical head of wheat) and removing anthers. Then he inserted the anthers of one strain of wheat into the antherless florets of a different strain of wheat. In this manner, pollen of one strain of wheat germinated (developed) within the florets of a different strain. And the results were seeds of a hybrid - an entirely new strain of wheat having some characteristics of both "parent" strains.

Dr. Borlaug cross-pollinated strains of Japanese dwarf wheat with strains of very-high-yield winter wheat from the U. S. Pacific Northwest. Later, he combined their various "offspring" with rugged types of native Mexican wheat. The end result was a number of hardy, high-yield strains of wheat known as the "Mexican dwarf varieties.

This new wheat revolutionized Mexican agriculture. Thanks to Dr. Borlaug's work, soil that once yielded fewer than 11 bushels an acre (a bushel of wheat contains about 60 pounds) was soon providing more than 30 bushels an acre. In the year of Dr. Borlaug's arrival, Mexico had to import 10 million bushels of wheat. Ten years later, Mexico was producing enough wheat to meet its own needs.

In 1963, Dr. Borlaug turned his attention to famine-threatened India and Pakistan. And he started another green revolution there. He modified his new strains of wheat to match the environmental conditions of that part of the world. Through his efforts Indian farmers were soon reaping three to four times more grain from the land than in former years. Furthermore, the new wheat was easier to harvest, easier to mill, and it produced a more nutritious flour.

Inspired by Dr. Borlaug's lead, other agricultural researchers developed new high-yield strains of rice, corn, millet, and sorghum. As a result, the green revolution has in recent years spread and flourished throughout many lands. And the benefits to a hungry world have been enormous.

The world is now becoming aware of these benefits. A few days ago, the green revolution was specially honored. Iowa-born Dr. Norman Borlaug received the 1970 Nobel Peace Prize in Oslo, Norway.

Is the green revolution the final solution? Will it banish hunger and misery from the face of the Earth?

Many scientists don't think so! Let's see why.

In the process of solving old problems, revolutions usually introduce unexpected new problems. And the green revolution is no exception.

Many social scientists say that the green revolution is causing severe social and political unrest in many countries. How?

Since there's more grain on each head of the new "miracle" crops, considerably less labor is needed to harvest each bushel. Many landlords are finding out that they can reap a handsome profit by farming the land themselves. As a result, tenant sharecroppers are being driven off the land. Where can they go?

These peasants crowd into the already overcrowded city slums of Asia, Africa, and Latin America. Since little work is available for them there, most of the displaced peasants end up living in terrible poverty and grinding misery. Unless something is done to improve their lot, they may sow the seeds of blood-red revolution.

Prime Minister Indira Gandhi of India recently stated: "The warning of the times is that unless the green revolution is accompanied by a revolution based on social justice, the green revolution may not remain green."

Other critics say that the green revolution was never really as green as it has been "painted by the world press." In other words, they're saying that the beneficial impact of the new grains has been exaggerated. In their opinion, too much hope is being placed in the green revolution's ability to end the world hunger problem. And they consider this to be dangerous. Why?

The critics feel that all the talk about the green revolution providing more food for everyone is distracting attention from the more important struggle to slow the world population growth rate.

The noted American plant biologist William C. Paddock has called the green revolution a "cruel joke." He also stated, "The revolution is green only because it is being viewed through green-colored glasses. Take off the glasses, and the revolution proves to be an illusion - but devastating in the damage it can do to mankind's tardy efforts to limit the world's horrendous population growth."

Dr. Paddock concedes that the new grains, use of fertilizers, and improved farming methods have greatly increased the yields of certain crops per acre in many parts of the world. However, he adds, "My guess is that the best farmers on the best land are profiting substantially from the green revolution. But the report that hundreds of millions of rural people are benefiting is open to question."

Dr. Paddock credits the increase in food production in the past few years partially to the green revolution and partially to the good growing weather in southeast Asia. What will happen when the green revolution "loses steam" and the weather takes a turn for the worse? What happens if blight stalks the new varieties of grain?

Before the green revolution, peasants in the poorer countries used varieties of grain that had been used in those regions for thousands of years. Though these strains did not provide a very high yield, they did possess special genetic characteristics (hereditary traits). These evolved long ago. And they enabled the grains to resist the various threats found in the region. However, new high-yield hybrid grains being introduced into the area would not have all those threat-resistant genetic characteristics. Therefore, the new crops could be open to various blights. And blight could wipe out an entire harvest.

In 1970, Southern leaf blight (a fungus pest) infected the hybrid corn crops in Illinois, Iowa, and Indiana, and caused considerable losses. Of course, there was no resulting famine in our rich country. The only noticeable effect was an increase in corn prices. But what would be the effect of such a blight in a poor, developing country?

Most scientists agree that the green revolution has brought many benefits to a hungry world, but it has also brought many new dangers. And while we applaud the pioneering work of Norman Borlaug and his associates, we must not be blinded to the perils brought on by the green revolution. We must recognize those perils and find ways to overcome them.

-- Michael Cusack

Questions and Activities

1. Is our world food supply getting better or worse?
2. What are the two alternative ways to solving our food problems?
3. What are the three ways being tried that will improve the amount of food produced?
4. What is the Green Revolution?
5. How did the Green Revolution get started?
6. What are some of the characteristics scientists hoped to develop in the wheat in Mexico?
7. How is cross-pollination different from self-pollination?
8. What is a hybrid plant?
9. How did the Green Revolution help the Indian farmers?
10. What kind of new problems did the Green Revolution cause?
11. Why does Dr. Paddock criticize the Green Revolution?
12. What is blight?
13. Why does the blight or other crop failures affect underdeveloped countries more than the United States?

PLANTS THAT EAT ANIMALS

Most food chains consist of animals eating plants. During the natural formation of plants and animals mother nature made a few exceptions. The Venus fly trap is one of the most commonly known examples of a plant that eats animals. Others are the yellow-green pitcher plant, headed pitcher plant, purple pitcher plant, sundew, bladderwort, and many others.

Why do these plants capture and eat insects? No one knows for sure. These plants, like other green plants, obtain minerals and nutrients from the soil and have the ability to produce their food by using sunlight, water and carbon dioxide. These insect eating or carnivorous plants are most often found growing on soil poor in nitrogen and phosphorus. Several scientists believe these plants obtain the additional nitrogen and phosphorus and some other minerals they need from the insects they eat.

These predatory plants have a variety of ways to capture their prey. The Venus fly trap has a clam shaped leaf that will close quickly when an insect touches sensitive hairs on the center vein of the leaf. The pitcher plants use nectar to attract insects into its pitcher where they become entangled in pitcher's hairy lining. After exhausting themselves trying to escape, the insects fall into a liquid at the bottom of the pitcher. The sundew has glue-tipped leaves that stick to insects; then the insects is enclosed in the leaf as it rolls up. One of the most exotic is the bladderwort. The bladderwort waves tiny tentacles in the water to attract a tiny water animal. When the animal gets near the tentacles a trap door snaps open and the victim is sucked inside and the door closes. A cricket is the largest animal ever observed being captured by a plant. No jungle plants are capable of eating cows or men as shown in movies and heard in tall tales.

Once the plant has captured the insect, it is not chewed like our food is. The plant produces chemicals that cover the insect and dissolve minerals from its body. These dissolved minerals travel into the plant and are used by the plant. This is very similar to what happens to food inside our stomachs and intestines.

Many people think the carnivorous plants are only found in tropical areas. Some are found in the tropics, but many are found in the swampy areas of the United States. North Carolina has the most abundant collection with others found in Florida and Mississippi.

Questions and Activities

1. What does the word carnivorous mean?
2. What part of the world would you visit to find insect eating plants?
3. What do scientists think the plants get from the insects they eat?
4. What kind of soil do the insect eating plants usually live in?
5. Can the carnivorous plants make food like other green plants?
6. Describe the way carnivorous plants eat their prey.
7. Obtain a carnivorous plant from a floral shop and keep it as a house plant.
8. Make a picture collection of carnivorous plants and tell the name of each and where it naturally grows.

PLANT GALLS: HOST AND PARASITES

Little noticed, but highly interesting, is the great variety of bumpy growths found on plants called galls. These tumor like growths that can be found on roots, stems, leaves, or buds are caused by bacteria, fungi, viruses, and insects. These galls can be hardly large enough to see to a few inches across. The shape can be round, oval, or stringlike. The outer shell ranges from shiny to sticky to hairy, through bumpy. Each different kind of gall results from a different kind of insect.

The majority of plant galls you will observe are caused when insects lay their eggs in the plant stem or leaf while it is growing. The presence of the eggs causes the plant to form the growth or gall. The eggs will hatch into larvae inside the gall and the larvae will remain inside the gall for shelter and food for a period of time before boring a hole in the gall wall and leaving. This is an excellent example of where a plant is a host and an insect is the parasite.

The plants most often used by insects are roses, willows, goldenrod and oaks.

Questions and Activities

1. Visit wooded areas or fields with wild flowers and collect samples of insect galls.

2. What kind of plants will most likely have galls?

3. If you see a hole in the gall wall what does it tell you?

4. Why is the insect causing the gall called a parasite?

5. Why is the plant containing the gall called a host?

6. Explain what is meant by saying galls represent a parasite-host relationship.

7. Using the library find out what kinds of galls are caused by different insects.

PLANTS HAVE A FEW TRICKS, TOO*

By Arthur W. Galston

They cannot run and they cannot fight, but plants have evolved a variety of ways to survive

All creatures living in the wild are subject to attack by predators, and their survival as a species depends in large measure on their success in fending off such attacks. Animals have many obvious self-defense mechanisms. Some, for example, hide from enemies by merging into the landscape so that it is difficult to see them; others hide by deliberately popping into a hole or under a rock. Because of their speed, some creatures outrun potential predators, while others outlast them by superior stamina during a long pursuit. A cornered or alarmed animal can ward off an enemy by obnoxious odors, gestures, or noises, and in a pinch can stand and fight off an attacker.

Plants, by contrast, seem at first sight to be relatively defenseless against attack, but a closer look reveals that they do have some mechanisms for warding off other organisms. For the most part, they are incapable of sufficiently rapid motion to do damage to an animal, although the insect-trapping devices of the sundew and of Venus's fly trap have been widely popularized. Upon mechanical stimulation the leaves of the sensitive plant will rapidly fold, which is said to protect the plant against grazing animals.

Another kind of movement results from the sensitivity and coiling growth of tendrils and other climbing organs; this permits some vines to grow over trees and, as in the case of the strangler fig, to completely kill the host. The tree can do nothing to escape the ever tightening clutches of its unwanted epiphyte.

Most successful plant defenses are exerted against insects and microbes. It is well known, for example, that among closely related varieties or species of plants, some are eaten by insects while others are not, and that some are susceptible to a disease while others are not. In such cases the differences between the related plants are often a clue to their defense mechanisms. Protection may be structural; some leaves are very leathery in texture and are covered on both surfaces by a waxy material or a thick, cushiony tuft of matted hairs. Such structural modifications of the leaf's surface repel some insect predators much as thorns repel some animals.

Other defense mechanisms are more chemical. For example, many wild plants contain bitter tasting chemicals whose value to the plant is not well defined. Because of a general belief that everything in a wild creature must have some function, it has been suggested that these materials may discourage insects and large animals from eating the plant. Similarly, strong smelling materials like those of the onion and mustard are said to repel some insects at a distance, before they even get to the plant.

*Reprinted from Natural History, Pages 26 - 28, December 1972.

Questions and Activities

1. What are some ways animals protect themselves?
2. What is the biggest disadvantage plants face in defending themselves?
3. Describe three ways plants are adapted to protect themselves.
4. Can plants capture animals? How?
5. How does a sensitive plant protect itself?
6. What are plant tendrils and how do the plants use them?
7. Where do you think the strangler fig gets its name?
8. Which groups of animals can plants best defend themselves against?
9. How does having thick or hairy leaves help the plant?
10. Have you ever tasted a plant that was bitter or sour?
11. Can you name some plants that smell bad? Which ones?

YES-THERE ARE ENDANGERED PLANTS!*

By Michael Cusack

Close your eyes. Think of Florida for a minute. What do you "see"? Tall coconut palms, swaying in the breeze? Many people think of these tall, graceful, tropical trees when they think of Florida. They're often called royal palms. About two million of them grow in the coastal areas of southern Florida. They add to the beauty of such cities as Miami and Palm Beach.

But, scientists say, by 1982 there may not be a single tall coconut palm in Florida. Why?

Royal coconut palms are dying! They're being killed by a strange tree sickness called lethal yellowing. Scientists don't know how to stop its spread.

Lethal yellowing has hit palm groves in parts of Africa and in all the countries of the Caribbean. Between 1962 and 1972, the plant sickness killed more than a million royal coconut palms in the island nation of Jamaica. To replace those tall palms, the Jamaicans brought in Malayan dwarf coconut palms. The dwarf palms don't get the disease.

In 1965, lethal yellowing spread to the Florida Key. And 15,000 tall palms died on Key West alone.

In 1971, the tree sickness reached the Florida mainland. Now, it's killing coconut palms in and around Miami. The disease is spreading north and west. It may soon give southern Florida a whole new look.

The deaths of big, beautiful trees remind people that certain plant species (types)--like certain animal species--are in danger of disappearing from the Earth. In fact, about 2,000 different major plant types are endangered. There are about 20,000 familiar, major plant species in the world (excluding the fungi and tiny, microscopic plant species). That means that one out of every 10 of these plant species is in danger of disappearing in the next few years.

Some of these plant types are threatened by disease. But most of them are endangered by the works of man.

In Brazil, Columbia, Venezuela, and other parts of South America, large sections of tropical rain forest are being cut away to make room for roads, towns, and farmlands. When a rain forest disappears, many strange plants go with it. These plants are then lost forever.

Might some of those plants have been of special use to man? We'll never know for sure! All over the world, wild places are being "tamed." In the process, certain wild plant species are lost or endangered.

New roads open the wilderness to campers, hikers, sportsmen, and, finally, to summer homes. Then, fragile plants are buried, trampled on, and poisoned by automobile exhaust fumes.

Most people view swamps and marshes as wastelands. So they drain and fill these wet places. Then they put them to use. Roads, homes, factories, ball parks, and airports are built there. Many towns use their wetlands as garbage dumps.

*Reprinted from Science World, Pages 16 - 19, November 27. 1972.

During the past 200 years, more than half of all the wetlands in the United States have been drained and filled. Thousands of acres of reeds, swamp grasses, and wild flowers have disappeared. Some wetland plants have become quite rare. And countless swamp rabbits, mink, muskrats, otters, raccoons, snipe, pheasant, wild ducks, and geese have lost their food and shelter.

In many places, scraggly mixed forests of "useless" trees and shrubs are completely removed. They're replaced by neat rows of "useful" pines. In a sense, a wild forest is changed into a "wood-crop land." An area that may have held hundreds of different tree types is now home to just a few species. And if any "useless" plants sneak in, they are promptly weeded out with herbicides (plant-killing chemicals).

Herbicides are now also weapons of war. Vast sections of rain forest in Indochina (Vietnam, Laos, and Cambodia) have been stripped bare by bombing. Some scientists say that war has changed the ecology of the region forever. And many interesting plants that grew only in parts of Indochina may have been lost forever.

Sometimes, even man's good efforts can lead to the destruction of certain plant types For their own protection, wild animals are often herded into sanctuary areas. There, the animals have food and water. And they're protected from human hunters.

But too many animals of one type may crowd into a wildlife preserve. When that happens, those animals may wipe out certain plant types. In some of Africa's wildlife preserves, there are too many elephants. And those elephants are destroying trees. The elephants are particularly rough on the big, ugly, mysterious, life-giving baobab trees. Elephants could wipe out the African baobabs. Then, many other animals would suffer.

So far, people haven't worried much about endangered plants. Scientists have collected samples of some of these plants into botanical gardens ("plant zoos"). But few attempts have been made to set up sanctuaries for endangered plants in the wild. Maybe, that will change soon.

The part of Mexico known as Baja ("lower") California is wild and rugged. A great many unusual plants grow there. Most of these plants are found nowhere else on Earth. They include the boojum tree and the night-blooming cactus called sour pitahaya.

Now the unusual plants of Baja, California may be in danger. Why? New highways are slicing deep into the peninsula. Resort hotels and vacation homes are being built along the coast. Hordes of tourists may not be far behind.

What's being done to save the strange plants of Baja, California from the threatening hordes of cars and people?

Mexican officials and scientists have set aside wildlife areas. Those are places where many of the most unusual plants grow. They will be far from traffic, and they will be "off limits" to most people.

Several other countries have set up sanctuaries to preserve wild plants. There's a large one on the Swedish island of Oland. A great many rare wild flowers grow there.

United States nature lovers are now trying to save many wild places. Groups of concerned citizens are buying and preserving marshes, swamps, and forests. In many places, they're urging local governments to preserve wild areas and all the plants and animals in them.

A good example of this has been the effort to save New Jersey's Pine Barrens. This is a large "unspoiled" area in the southeastern part of the state. The large area is covered mostly with pitch pine trees and various types of oak trees. Many rare shrubs also grow there.

Because New Jersey is a crowded industrial state, home builders, road builders, and industrial developers have tried to "invade" the area. But concerned citizens have persuaded the state legislature to keep them out.

Recently, the area has faced another threat. There are many sources of water in the Pine Barrens. And thirsty towns and industries in northern New Jersey want to tap those water sources. However, a group of students from Princeton University showed that if water were drawn from the area, the ecology of the area would be ruined.

Now, concerned citizens, scientists, and state leaders are making plans to keep most of the Pine Barrens "forever wild."

How many other wild parts of our polluted planet can be saved from man's "taming" urge?

Questions and Activities

1. What does the word endangered mean?
2. What is lethal yellowing?
3. Why did the people of Jamaica bring in Malayan dwarf coconut palms to replace their royal coconut palms?
4. How is lethal yellowing affecting the Florida trees?
5. What fraction of our plants are in danger of disappearing from the earth?
6. What is the greatest threat to plants?
7. Describe some of the ways man is destroying plants.
8. How have wars affected plants?
9. Have wildlife preserves always been a success?
10. What is important about Baja, California?
11. Why are people trying to save the Pine Barren area?
12. What kind of things are people doing to save plants from becoming extinct?

THE AMAZON JUNGLE - FRAGILE GIANT*

by Arnold Updike

EEEEEEEEOOOOW! Grink, grrrick, grink, grrrick, grink, grrrick. As night falls, the rain forest comes alive with sound. Crickets and tree frogs are the rhythm section of this jungle orchestra. From dusk to dawn, they "rap" out a metallic beat that echoes through the soaring trees and tangled vines.

Multicolored parrots and parakeets flutter from tree to tree, adding their cries and screeches to the growing din. Red howling monkeys scream into the damp air. The roar of a jaguar seems to vibrate the delicate ferns springing from the wet forest soil. As the shadows of dusk merge into the darkness of night, other animals add their squeaks, chatter, whistles, and grunts.

A capybara, the world's largest rodent - a sort of giant guinea pig, four feet long - noses toward a stream in search of a tasty water plant. A jaguar prowls nearby in search of a capybara. So does an alligator gliding almost soundlessly across the stream. And a 20-foot-long boa constrictor coils around the thick branch of a twisted tree, waiting for its meal.

This is the vast Amazon rain forest. Covering an area of about 12,000,000 square kilometers, it blankets half the continent of South America. Many words come to mind to describe this mighty forest - teeming with life, lush, indestructible. But, surprisingly, the word indestructible is not a member of the set. For this great ecosystem (animal and plant community) rests on a shaky foundation - a foundation being chipped away by man.

Let's see whether we can discover how and why man can destroy a forest, one that could easily swallow up two-thirds of the United States.

As the population of South America grew in recent years, more and more land was needed for farm crops. There seemed no place to turn but to the seemingly fertile soil of the Amazon rain forest. Men and bulldozers slashed and gouged the jungle. They cleared acres and acres of land by setting the vegetation ablaze. Then they planted crops.

But, for no apparent reason, the crops failed to grow well. And after a few poor harvests, the land seemed almost unable to "feed" the crops at all. The earth "refused" to bloom. And the would-be farms were abandoned. Now came another surprise: The jungle did not invade and "take over" the abandoned land. The slashing, gouging, and burning had turned the entire area into a permanent wasteland. How come? Many scientists have asked this question. Here are some of the answers they have uncovered.

One cause of the ecological disaster is rain. You may wonder how rain - which is a necessity for a rain forest and for food crops as well - can prevent the growth of a new rain forest or the growth of food crops.

Think for a moment of how long and how much rain has been falling in the Amazon region over the years - 100 inches of rainfall a year, over millions of years. (The average rainfall in the eastern U. S. is under 40 inches per year.) How do you believe this has affected the water soluble minerals (those that dissolve in water) in the Amazon soil? And, remember, this is the soil from which the Amazon Jungle rises. If you guessed that the rain has washed away these minerals, making the Amazon soil one of the poorest in the world, you're right!

*Reprinted from Science World, Pages 4 - 5, September 14, 1970.

Why don't farmers use fertilizers in such soil? Usual methods of adding fertilizers to soil are worthless in the Amazon jungle. The plant foods are rapidly washed away.

Now, you're probably asking: how could the jungle exist on such poor soil, before it was ever touched by man? That is the very question that is being pondered by many experts in plant science.

Without getting into the problem of how the present jungle evolved - that is, how it developed from earlier plants - let's take a closer look at how existing jungle plants get the minerals they need.

Like other living communities, the rain forest community is continuously recycling - putting back into "food form" - certain minerals, such as sulfates, nitrates, phosphates, potassium, magnesium, iron, and calcium, to name some of the important ones. These substances are present in the tissues of almost all green plants (and animals, for that matter).

When plants or animals die, these substances are "unlocked" for reuse. In areas where there is not too much rainfall, this unlocking - or reprocessing - is accomplished mostly by decay bacteria. These microorganisms break down the plant or animal tissues. In the process, mineral foods are returned to the soil in water-soluble form. Plants absorb the dissolved substances through their roots and use the minerals to build new tissue.

But minerals returned to the soil in water-soluble form in the Amazon rain forest would soon be washed away - before they could be "captured" by plant roots. How, then, is the lush plant growth maintained in the undisturbed rain forest?

Recently, Dr. Nellie Stark and Dr. F. W. Went, of the University of Nevada, suggested that the vital reprocessing role in the Amazon Forest is not played by bacteria but by certain kinds of fungi (non-green plants that, unlike green plants, cannot make their own food). These fungi digest (break down) dead plant and animal tissue. In the process, water-soluble minerals are freed from the dead matter. Here's where the fungi play a key role. The fungi "trap" these minerals before they pass into the soil, where they would quickly be washed away. And the fungi pass the minerals directly into the cells of the roots of trees and other green plants.

The fungi actually live in between and around the cells of the root, with "threads" extending into the soil and the decaying plant and animal matter. This partnership, one kind of symbiosis (sim-by-OH-sis, a Greek word for "living together"), is not onesided in favor of the green plant. The fungus is thought to absorb some of its foods - possibly sugar or starch made by the green plant's leaves - from its partner's roots. The name for this type of symbiosis is mycorrhiza (my-co-RYE-zah), which means "fungus root."

Once one partner (tree, vine, or bush) is destroyed by man, bulldozer, or fire, the other dies. Then, without fungi to support the life of the green plants, jungle seeds rooting in cleared Amazon areas soon die of starvation. And the land remains barren - perhaps forever.

However, scientists are searching for ways to re-grow the jungle where other men have wiped it away. Since the green plants will not grow without their specific fungi partners, the only solution may be to transplant trees, bushes, vines, and flowers together with the soil in which they are rooted - a long and difficult task, but perhaps the only way to bring back the sounds of the rain forest to the man-made deserts.

Questions and Activities

1. Where is the Amazon Jungle located?
2. What is man doing to the Amazon Jungle? Why?
3. What happened to the jungle area when it was turned into farmland?
4. How much rainfall does the Amazon receive each year?
5. How does the rain harm the soil's ability to produce plants?
6. Why was the adding of fertilizer nearly useless?
7. What does it mean to say that minerals are recycled in the jungle?
8. How is the mineral recycling process different in the jungle than in areas like Kansas grasslands?
9. Explain how the fungi - jungle plant partnership helps both plants?
10. How do scientists think they can re-establish the jungle growth in the man-made deserts?

BAOBAB The Upside-Down "Tree of Life"*

by Michael Cusack

Africa!

What does that name make you think of? Dense, damp, steaming, teeming jungles? Vast, sandy deserts?

Of course, there are jungles in Africa. There are also deserts and farmlands. But most of Africa is covered by fairly dry grasslands.

Much of this dry grassland is dotted with tough, thorny bushes. And here and there, strange, giant trees grow. People call them baobab (BAY-oh-bab) trees!

Baobab trees are not very tall. One of them would look like a midget next to a California redwood. Yet, the baobab has an enormous trunk--as big around as that of many a redwood. Many baobab tree trunks measure more than 150 feet around.

In one Central African town, the hollowed-out trunk of a living baobab tree is used as a bus stop shelter. Up to 30 people can stand in it at the same time.

Creased, wrinkled folds of very thick bark cover the mighty baobab tree trunk. This bark gives the trunk a lumpy look.

Weirdly shaped branches spread out from the short, wide, lumpy trunk. Those branches look like roots reaching for the sky.

The baobab is an ugly tree!!!

When the famous explorer Dr. David Livingstone (1813-1873) saw a baobab tree, he called it "a carrot planted upside down."

Many other people have thought of the baobab as an "upside-down tree." One old African story says that God became angry with this tree while He was creating Africa. Why? The baobab wouldn't grow where He wanted it to. So God tore up the tree and pushed it back into the ground upside down.

According to another old story, God gave the job of planting the baobab to a hyena. But the hyena was angry with God for giving him a terrible laugh. "To get even," the hyena planted the tree upside down.

Many other old stories say that the Devil did it.

Despite these stories, and despite its ugliness, various African tribes have worshipped the baobab tree. They considered it a center and source of life. One tribe still believes that God lives in the high branches of a baobab tree.

There's a reason for these beliefs. In a way, a baobab tree is a center and source of life. Every part of the baobab tree is used by men and animals. In fact, the incredibly ugly baobab is perhaps the most useful tree in the world. Let's find out why.

Baobab leaves are eaten by people and animals. These leaves are rich in vitamins. When cooked, they're said to taste like spinach.

*Reprinted from Science World, Pages 9 - 11, May 3, 1972.

The pulpy fruit of the baobab can also be eaten. Some monkeys will travel a long way for it. The roots of young baobabs are said to taste like asparagus. And dried baobab seeds can make a tasty imitation coffee.

In many parts of Africa, baobab bark is made into waterproof hats and drinking cups. A bright red dye is made from the roots of older baobab trees.

A strong glue is made from the pollen of baobab flowers. Ground baobab seeds are used as a fertilizer. Burned baobab seeds are used to make soap. Even the smoke from burning baobab seeds has a use. Some Africans use it to drive insects away.

What's more, all parts of the baobab tree are used as medicines.

Strangely enough, the baobab isn't useful in the way most other trees are. Its wood is no good for building. Why? Baobab wood is too soft and spongy. Houses and furniture made with this wood might break and crumble in a very short time. However, the soft, spongy baobab wood can be pounded into fibers for ropes and mats.

In some parts of Africa, baobab trees help solve the housing problem in a special way. People hollow out the trunk of a living baobab. Then they move in. Home in a tree!

Baobab trees are useful to people and animals in countless other ways. We couldn't list all the uses. But the baobab has one all-important use. When rain has not fallen for a long time where baobab trees grow, water holes turn into dust holes. Plants wither. Men and animals go thirsty. Then, a baobab may be the last source of clean water around.

Where baobab trees grow, there are two seasons--rainy and dry. And baobab trees seem to be specially adapted for this two-season environment.

The rainy season usually begins in October. It may last for a few months. During that time, the baobab's spreading branches channel water down the sides of the huge trunk. And the water forms a spreading puddle around the base of the tree. As the water soaks into the ground, the baobab's broad network of roots soaks it up. The roots are close to the earth's surface, and "they don't miss a drop."

The baobab stores moisture in its soft, spongy wood. The tree's thick waterproof bark holds the moisture in.

Rainwater also settles in a basin-like hollow at the top of a baobab tree trunk. Some of that water may stay there all through the long dry season. Such a tree-top "oasis" may have saved the life of many a thirsty traveler.

If you were to approach a giant baobab near the end of the dry season, you wouldn't think that the tree was a center of life. From a distance, the tree would look dead and deserted. Its naked branches form a spidery pattern against the sky.

Actually, the baobab is "full of life." Small animals live among the roots and in hollows of the trunk. Birds nest high in the branches. And insects hide in the tree's many nooks and crannies.

Thousands of animals may live in a single baobab. Most of them tend to "hide out" during part of the dry season. But after the coming of the rains, a great many animals may be seen scurrying among the leaves, flowers, and fruit that blossom on the baobab tree.

In addition to all the animals that live on, in, and around a baobab tree, countless other animals visit a baobab during the year.

Baobab trees look as if they've been around forever. But no one really knows just how long they've been here. There are no "growth rings" in the trunk of a baobab. Some scientists believe that many baobabs are more than 2,000 years old. If that's the case, baobabs--along with California redwoods and bristlecone pines--are the oldest living things on Earth.

A giant baobab looks as if nothing could hurt it. It can survive grassland fires. And it can withstand long periods of drought.

But, of course, a baobab can be hurt. Two of its animal visitors bring danger.

The first dangerous visitor is man. People may strip away too much bark and thus damage a tree. Or they may chop down a baobab to make way for roads, towns, or farmlands.

The other dangerous visitor is the elephant. In the dry season, a thirsty elephant will rip open a baobab tree trunk to get at the water in the pulpy wood. An elephant will chew great amounts of baobab wood to squeeze out the water. A few of these elephant visitors can destroy a huge baobab tree.

Elephants have probably been destroying baobabs for thousands of years. But until recently, there were a great many baobabs in Africa. The loss of a few could hardly be noticed. Now, the situation is different.

More and more of Africa is being turned into towns and farmland. As a result, the areas where baobabs grow and elephants roam are getting smaller.

As more and more elephants are crowded into a given area, the baobabs in that area are bound to suffer.

And when a baobab dies, more than just a tree is lost. When a baobab dies, thousands of animals lose their homes, their sources of food, and their sources of water. When a baobab dies, a little bit of "wild" Africe is lost!

Questions and Activities

1. Where is the baobab tree found?

2. How does the baobab tree differ from other trees?

3. What kind of other plants live in the area where the baobab tree is found?

4. What are some of the stories that explain why the baobab tree appears so different?

5. How do people use the baobab tree?

6. How many seasons does this area of Africa have?

7. How do animals use the baobab tree?

8. What are the two primary threats to the baobab tree?

9. Should we be concerned about saving the baobab trees?

WHEN PLANTS "MUNCH" METALS*

by Malcolm Weiss

Man-made deserts cover some parts of the Earth. For miles around, practically nothing grows. With no roots to hold the soil together, the wind crumbles the dirt. The soil becomes fine-grained and porous, like sand. Rain water seeps quickly through it.

What's wrong with the soil? It's been poisoned by metals and their ores.

Such deserts are scattered all over Great Britain, for example. They mark the sites of old worked-out lead, zinc, tin, and copper mines.

Ores of these metals were taken from the ground and refined. This is a process by which the metal is separated from the ore and purified. The waste left after refining was strewn over the ground around the mine.

These wastes still contain at least one per cent of the metal ores. Tin, lead, zinc, copper, and their ores are highly poisonous to plants.

Thus, the area around a mine becomes a wasteland. There is no way to remove the toxic wastes. Waiting for rain to wash them out would take tens of thousands of years. Still worse, the wastes tend to become more toxic (poisonous) with time.

Can these deserts be reclaimed - made capable of supporting plant life once again?

Until recently, the answer seemed to be No. Then Dr. Anthony Bradshaw, a botanist - plant scientist - with the University of Liverpool, Liverpool, England, noticed something strange: There were plants growing in the polluted soils!

True, the plants were few, and far between, but they seemed to be thriving. A closer look showed that the plants were ordinary grasses, such as bent grass and sorrel.

Dr. Bradshaw was puzzled. Did this mean that all bent grass and sorrel plants are tolerant of metal-poisoned soils?

To find out, the botanist prepared large numbers of culture solutions. These are water solutions containing, in dissolved form, all the minerals needed for healthy plant growth. Next, Dr. Bradshaw added soluble toxic metal salts to half of the solutions. Then, the scientist collected seedlings of bent grass and sorrel that were growing in normal soil, and seedlings of both plants that were growing in polluted soil. Seedlings of each type were suspended in each culture-solution tank, with their roots in the solution.

The result was clear-cut: Seedlings taken from polluted areas grew in both normal and toxic culture solutions. But seedlings taken from normal soils quickly died in the toxic solutions.

Dr. Bradshaw carried his experiments one step further. He gathered seeds from tolerant grasses (those not injured by toxic wastes) and planted them in polluted soil. The new plants proved to be tolerant also.

This meant, reasoned Dr. Bradshaw, that the metal-tolerant grasses are new strains (varieties) of bent grass and sorrel. The ability to survive in toxic soils is an adaptation. This adaptation can be passed on from one generation of plants to the next.

*Reprinted from Science World, Pages 4 - 6, November 1, 1971.

But this only raised another puzzling question. Practically all British mines have been dug within the past 200 years. How, wondered the botanist, did the plants evolve tolerant varieties so rapidly? Normally, it takes many thousands -- often millions -- of years for new varieties of plants and animals to evolve and spread.

One possibility occurred to Dr. Bradshaw. Perhaps the tolerant strains are the result of a mutation--a sudden change in one or more genes. Genes are the basic units of heredity in living things.

Did such a mutation occur naturally in the non-tolerant population of these grasses from time to time? Dr. Bradshaw collected thousands of seeds from non-tolerant plants. He planted the seeds in toxic culture tanks.

What happened? Out of every thousand seeds, three or four survived and grew to maturity in the toxic environment. In turn, all the offspring of these plants were tolerant. So the tolerant strains are, in fact, a mutation from the normal ones.

This raised still another question. In an unpolluted area, the grasses produce three or four tolerant seeds out of every thousand. But the number of tolerant adult plants in such an area is much smaller, say, one in 10,000. Why?

Dr. Bradshaw points out that tolerant strains of bent grass and sorrel are smaller than non-tolerant strains. The tolerant varieties also have smaller leaves and grow more slowly.

All of these traits are adaptations to water-scarce conditions. Small plants that grow slowly need less water. The smaller the leaves, the less water evaporates from them. And we've already seen that water seeps quickly through sandy, metal-poisoned soils, leaving them dry again.

But what happens when tolerant seeds start sprouting in normal soils? Then, says Dr. Bradshaw, their adaptations become handicaps. Why?

Each tolerant seedling is surrounded by many non-tolerant seedlings. They rapidly outgrow the smaller, tolerant plants, shutting off their sunlight. So, few tolerant seedlings survive into adulthood.

But in toxic soils, the non-tolerant plants can't grow at all. The tolerant plants have no competition, so they thrive and spread.

That's what took place in Britain over the past 200 years, says Dr. Bradshaw. Winds carried a few tolerant seeds into toxic areas, where they could grow to maturity and produce more tolerant seeds, spreading the plants wherever the ground was poisoned by metal.

Even so, as Dr. Bradshaw had noticed earlier, the tolerant plants were few, and far between. Dr. Bradshaw thinks the reason is that the poisoned soil is very poor in minerals needed by the plants. So a given area of the poisoned soil can support only a few plants.

Dr. Bradshaw hopes to change this be adding fertilizer to the toxic soils. Then, he thinks, tolerant plants can be grown in a thick "carpet" over the poisoned soil. As generations of plants die and rot, their remains will produce a healthier, less toxic soil. Within a few decades, the poisoned soil may be completely reclaimed.

Will it work? If so, then plants that munch metals will master old mines.

Questions and Activities

1. What caused the man-made deserts referred to in this article?
2. What is the poisonous substance in these man-made deserts?
3. How long would it take for rain water to wash the poisons from the soil?
4. What kind of plants did Dr. Bradshaw find growing in the poisoned soil?
5. What kind of experiment did Dr. Bradshaw perform to see if the plants growing in the poisoned soil were different than the plants growing in the normal soil?
6. What does it mean to say a new strain or variety of plant has developed?
7. What kind of adaptation did the new strain or variety of plants possess that helped them survive?
8. What is a mutation?
9. What happened to the new variety of plants when they tried to compete with normal plants in good soil?
10. What does the word **toxic** mean?
11. How did the new plants differ from the normal plants?
12. How does Dr. Bradshaw explain the distance between the plants in the poisoned soil?
13. How does Dr. Bradshaw plan to increase the number of plants growing in the poisoned soil?

THE BATTLE OVER WILDERNESS*

How much of the wilds should we preserve against the encroachments of civilization?

Ten or fifteen years ago the word ecology was barely known or understood. Today it is virtually a household word. And now the wilderness concept is capturing attention. Many Americans are concerned about saving wild, untamed places in their natural, untouched state. Whether or not they visit these areas, people like to feel that the wilderness is there, as a kind of natural counterbalance to the overpowering supertechnology of our time.

Wilderness--or lack of it--is also a source of controversy. How much of it do we really need? Where should it be located? What kind of wilderness should be preserved?

The idea of saving wilderness goes back at least a hundred years to the establishment of Yellowstone National Park. Large primeval portions of it were set aside to remain roadless and unimpaired. Soon after, New York adopted a law to prevent timber cutting in the Adirondack Forest Preserve, declaring it would be kept "forever wild." By the 1940's federal regualtions had been adopted providing for the designation of wilderness areas to be kept free of roads, logging, and commercial development. Before long, approximately 9,100,000 acres of the national forests had been earmarked as "wilderness" and another 5,500,000 acres as "primitive."

However, in the years following World War II, conservationists became alarmed as vast additional areas of high recreational and ecological value were invaded by bulldozers and chain saws. So environmental groups conceived and crusaded for the Wilderness Act, which Congress enacted in 1964.

The Wilderness Act defines wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." It established the National Wilderness Preservation System, composed initially of 54 areas in the national forests already selected as "wilderness." It also provided that other "primitive" areas be reviewed for possible inclusion, as well as roadless areas in the national parks and national wildlife refuges, and set up a procedure of public hearings on the desirability of protecting each area. This process is scheduled to be completed by 1974.

What is the use of uselessness?

Wilderness represents a large-scale recreational resource, but of a special kind. Besides the hiking, climbing, camping, fishing, canoeing, and hunting that it offers, it provides blessed relief from congested, mechanized, and noisy urban American. "If we do not permit the earth to produce beauty and joy, it will not, in the end, produce food either," the late Joseph Wood Krutch wrote. "If we do not value it as beautiful as well as useful, it will ultimately cease to be even useful."

Proponents of wilderness preservation agree. They insist that in wilderness all life is useful, whether or not it is immediately understood by the human observer or usable by him. Old trees, for example, may be unfit for lumber but furnish habitats for squirrels, raccoons, owls, insects, and woodpeckers. Many insect-eating birds hatch at the very time of year when insects near their maximum numbers.

*Reprinted from Changing Times, Pages 21 - 24, October 1973.

Preservationists cite practical points, too. Because the wilderness environment tends to be stable, it protects drainage basins of rivers and streams, insuring a steady supply of high-quality water--unlike strip mining and intensive logging, which often result in soil erosion and stream siltation. Then, too, wilderness serves as a living laboratory for scientists of many disciplines. Innumerable laws of nature can never be analyzed or understood without study of primeval conditions.

Yet preserving wilderness does evoke opposition. The mining industry asserts that civilization is based more on metals than on sentiment. It fought passage of the Wilderness Act and succeeded in gaining the right to stake new claims in designated wilderness areas of the national forests through 1983. Serious conflicts have arisen. In the White Cloud Mountains of Idaho, American Smelting and Refining Co. proposes large-scale molybdenum mining in an area that environmentalists hope to have set aside because of its natural beauty. In the North Cascades of Washington State, Kennecott Copper has been blocked, so far, from mining on land it actually owns within the Glacier Peak Wilderness.

The lumber industry is another vigorous opponent of some aspects of wilderness preservation. Advocates of saving wilderness want to leave the areas just as they are, but the National Forest Products Association declares that removing infested trees will keep forests beautiful and productive for future generations. It claims that dead and dying timber in undeveloped areas of the national forests are an "eyesore, a fire hazard and a potential source of disease infestation which could spread to healthy forests."

The NFPA charges that wilderness classification represents the work of an aggressive minority of outdoor elitists determined to reserve large areas for their own exclusive use and enjoyment. Actually, the Wilderness Act stipulates recreation as one of its primary purposes, so long as the types of recreation are in harmony with preservation of the resource over the long run, but the NFPA argues that this discriminates against the majority of Americans who travel by highway to national parks and national forests

The Forest Service's role

Not all the opposition to wilderness protection comes from industry. The Forest Service itself is considered antipreservation by environmental organizations like Friends of the Earth, the Sierra Club and the Wilderness Society. Even though it administers most federal lands that qualify under the Wilderness Act, the agency has shown little enthusiasm for expanding the Wilderness System. It insists that areas to be included must be completely free of the works of man. Environmentalists, on the other hand, claim that so long as intrusions are "substantially unnoticeable"--to use the language of the act--vestiges of an old road or early logging should not disqualify an area. With development prohibited, the advocates believe, nature would restore wilderness quality, as it has done in the Boundary Waters Canoe Area in Minnesota and the Great Smoky Mountains National Park astride the Tennessee-North Carolina border.

The eastern United States is now a battleground between these two conflicting viewpoints. The Forest Service administers some 23,000,000 acres of federal land in the East, extending from the White Mountains of Maine and New Hampshire to the southern Appalachians, Ozarks and Ouachita Mountains and the lake states. But the Forest Service states flatly that, except for three small sections of these lands already designated as wilderness areas, there are no further areas of qualified wilderness to be found anywhere in the East.

The environmental groups, however, are giving strong support to the 1973 Eastern Wilderness Areas Bill, now pending in both houses of Congress, which would establish 18 new wilderness units and designate 37 areas in 20 states for interim protection pending further study. George Alderson, legislative director of Friends of the Earth, calls the act "the last chance for protection of wilderness close to the big, eastern urban centers."

As an example, Alderson cites the proposed Joyce Kilmer-Slickrock Wilderness of approximately 32,500 acres in national forests on the North Carolina-Tennessee state line. The Forest Service administers some 10,000 acres of this land, the largest single block of virgin forest it controls in the East. It has been 50 years since the end of logging operations on most of the remaining acreage, and in that time regrowth has healed the scars. The entire area now displays a primitive, undeveloped setting, with a wide variety of animal and plant life. "Without wilderness protection," warns Alderson, "this exceptional area will soon be subdivided by roads and likely open to logging. The same is true in national forests throughout the East...we must act now."

Critics are also discontent with the Forest Service's recently completed inventory of all roadless, undeveloped areas within national forests of the West. From the start of the inventory in late 1971, according to Stewart Brandborg, executive director of the Wilderness Society, the opportunity for citizens to be heard at public meetings was extremely limited and the protests of conservationists ignored. The whole review, he charges, has been superficial and hurried, as if intended to eliminate public participation.

As a result of the inventory the Forest Service early this year announced a new list of the areas to be reviewed for possible designation as "wilderness." But Brandborg believes the 6,300,000 acres involved to be inadequate, since they amount to less than one-eighth of all roadless land inventoried. "When the Wilderness Act was passed," he declares, "everyone thought the Wilderness System might encompass 40,000,000 acres--possibly 50,000,000 acres at the most. Now we know it can be much more extensive, if concerned citizens do not sacrifice the opportunities."

How states and industry act

The wilderness act is not the only means of preserving a natural environment in federally administered areas. Two other federal laws--the Wild and Scenic Rivers Act and the National Trails System Act, both enacted in 1968--complement it.

The Wild and Scenic Rivers Act protects choice free-flowing streams and bordering lands from dam-building projects and commercial encroachment. Eight national rivers and one state wild river area are part of the Wild and Scenic Rivers System, and 27 others are listed as potential additions, to be studied and reported on by 1978.

The National Trails System Act protects the 2,044-mile Appalachian Trail in the East (about 740 miles of which are still located on private property) and the 2,350-mile Pacific Crest Trail in the West. Fourteen others were designated for possible inclusion in the National Trails System as scenic trails and 40 have been named as recreation trails, with 1976 as a target date for completion of the studies.

These federal laws have stimulated dramatic action by state governments and local groups.

New York has taken a leading role with its land use plans for Adirondack Park. Almost a million acres, in 15 separate tracts, are designated as wilderness. Other categories include primitive; canoe; wild forest; intensive use; wild, scenic and recreational rivers; and travel corridors.

Courtney Jones, vice-chairman of the Adirondack Conservancy Committee, emphasizes that, while recreation will have its place, in certain very popular wilderness areas the number of visitors may be limited in order to maintain conditions of solitude and challenge in a primitive environment.

In Maine public desire to save the majesty and solitude of the North Woods led to passage of the Maine Wildlands Laws of 1969 and 1971, which created a system of zoning, planning and periodic review, with special protection accorded to lakes, rivers and streams and to lands above 2,500 feet elevation.

The Michigan legislature voted last year to establish its own wilderness and natural areas system, consisting of wilderness areas of 3,000 acres or larger or an island of any size, wild areas under 3,000 acres, and natural areas, where the emphasis will be on scientific research and education. Michigan is also one of about 20 states to adopt its own wild and scenic rivers legislation. A distinctive feature of its law enables the state to zone adjacent lands to provide for their preservation when a county or township fails to do so.

Tennessee likewise has adopted both a Scenic Rivers Act and a Natural Areas Preservation Act, as well as a Trails System Act. High priorities are placed on areas under immediate threat of destruction, on those that could not be duplicated if lost, and those already in public ownership that are unique in character and should be saved from intensive development.

The positive programs have not always been initiated by public agencies. The Georgia-Pacific Corp., one of the largest landholders in the South, sold 25,825 acres of virgin salt marshes in the famous Gulf Hammock north of Tampa to the state of Florida for a modest $1,700,000 and arranged to sell to Georgia for $457,000 all of historic 6,000-acre Lewis Island near Darien, containing a large stand of virgin cypress that is a habitat for rare birds. Union Camp Corp. presented about 50,000 acres in the Great Dismal Swamp of southern Virginia, valued at $12,000,000, to the Nature Conservancy for ultimate protection as a national wildlife refuge.

The paradox of popularity

As public interest grows, wilderness areas have recorded tremendous upsurges in use, with unfortunate results. Little wonder, considering there are now over 10,000,000 backpackers. But the opportunities available to them are shrinking. Most U. S. trails are relics of past programs, mainly for fire protection. Over half the trail mileage is in national forests, but the total there has dropped one-third since 1945.

Between 1969 and 1972 camping and shelter facilities of the Appalachian Mountain Club among the high peaks of the White Mountains in New Hampshire have shown a 100% increase. In the spring of 1972, even before the summer hiking season, the club reported that shelter-campsite areas were being used by twice the number they were designed to accommodate. Baxter State Park, the largest wilderness in Maine, also is overrun with far more visitors than it can support.

Once overrun, such areas no longer impart a sense of wilderness. The damage to the resources becomes readily apparent. When five campers per summer use an area, a campfire is a harmless delight. When 500 campers build fires, they create catastrophe. For this reason, use is being increasingly regulated through quotas and permit systems.

Even among those who enjoy the outdoors most there are serious conflicts of views. Snowmobilers and ski tourers, trail bike riders and hikers, motorboaters and canoeists are all competing for the same room to roam. "Can anyone justify his presence in wilderness unless he goes there under his own power?" the wilderness enthusiest may ask. But the man on the machine is likely to retort, "The land is there to be enjoyed and this is our way of enjoying it."

William D. Ruckelshaus discussed this issue when he was head of the Environmental Protection Agency.

"Now we all like to walk in the woods, cook on a grill and listen to the radio," he said. "But surely it would be disastrous, not just for the nature lover but for the nation, if we turn all our parks into recreation areas and forget that they should be places to reestablish our links with nature....We should get busy right now and estimate our national recreation needs, relate them to our total recreational resources, and then make the best use of each resource that we can. We really haven't much time left."

Questions and Activities

1. Why do people want to save wilderness areas?
2. What was the first wilderness area set aside by the government?
3. Why was the Wilderness Act enacted in 1964?
4. What is a wilderness area as defined in the Wilderness Act?
5. What does this statement mean? "If we do not permit the earth to produce beauty and joy, it will not, in the end, produce food either?"
6. What groups opposed the Wilderness Act and why did they oppose the Act?
7. Which groups are strongly supporting the Wilderness Act?
8. How have some states established wilderness areas?
9. What problems result when wilderness areas become popular with the people?
10. How should we resolve the conflicting demands made on our remaining wilderness areas?

PARKS VERSUS PEOPLE*
A Critical Issue in Science

Once upon a time, our national parks were havens of peace. In the wilderness of a park, a person was free from the hustle, bustle, pressures, conflicts, restrictions, and noise of workday life.

Each year, more and more people discovered this. And, each year, more and more people thronged to a national park to "get close to nature."

Perhaps this is what the U.S. Congress intended in 1872, when it set aside a tract of wilderness in Montana "as a public park or pleasureland for the people." That tract of wilderness became Yellowstone National Park--the first and largest of the 283 areas making up the present 30,012,075-acre National Park system.

In the beginning, only a rich or very adventurous person could visit a national park. Why?

The parks were far from where people lived. Getting there usually involved a long train ride followed by a costly guided pony trek into the park.

Of course, some adventurers traveled into the parks on foot or on horseback. But there were no trails or signs to guide them, and few park rangers to protect them.

Then the National Park Service started "opening the parks to the people." Roads were carved through the wilderness. Cabins and lodges were built. Parking areas were cleared. Camp sites were set aside. Food stands, souvenir shops, rest stations, laundry rooms, information booths, and trailside museums sprouted where once just the deer and the antelope played.

In terms of making the parks available to the people, the program was a huge success. In 1960, 72,300,000 people visited the national parks. In 1970, there were 179,640,200 park visitors. Several million more were expected this year.

However, some conservationists (people concerned with saving the natural environment) claim that this "success" is really a "disaster." They say that the great popularity of some national parks is leading to the "destruction" of those parks.

Why?

To make room for people, and their cars, and their camper trailers with all the comforts of home, large sections of parkland were paved over. Each year, as more and more people crowd into the parks, more roads, parking areas, camp sites, and other facilities are needed.

In summer, the more popular parks--such as Yosemite, Grand Canyon, Yellowstone, Sequoia, and Mesa Verde--can be very crowded. Traffic jams are common. Camping areas become "instant suburbs." Shrubs are trampled. Trails are widened. Streams are polluted. Animals move out. Or, like the bears at Yellowstone, they become dangerous beggars. Fires are left smoldering. And litter piles up almost everywhere.

As a result, several national parks are no longer "havens of peace." People may go to those parks to get away from the pressures, conflicts, and restrictions of everyday life. But they find that the problems have "traveled with them."

*Reprinted from Science World, Pages 7 - 9, October 18, 1971.

Pollution, crowding, accidents, crime, and conflict are now part of the national park scene. In 1970 almost 200 people were killed in the national parks, and more than 4,000 were hurt. There were 374 arrests for serious crimes--murder, assault, robbery--and 19,418 arrests for lesser offenses--petty theft, destruction of wildlife, traffic violations, drug use.

"Urban blight is spreading to our national parks," say some conservationists. "And unless this blight is checked, there will be few beautiful wilderness areas left for anyone to enjoy."

In 1965, a scientific team studied the effects of people on the more popular park areas. This team reported some "ecological deterioration through overuse." That means that in some areas the delicate interrelationship of land, water, plants, and animals is being upset by the impact of masses of people.

When people trample an area, the soil is hardened. Some plants die. But the ecological damage is not limited to that area. The hardened soil will not easily soak up water from a heavy rainfall. The result? Runoff! Little streams of water rush off the hardened soil through the surrounding areas. And these streams can wash away topsoil and delicate vegetation.

Where there are many roads, parking areas, trails, and camp grounds, the runoff during a rainstorm can be substantial. And large park areas may be eroded (rich topsoil and plants can be washed away). In the end, some areas may be flooded, and others parched. This can cause the loss of many plant species. And when plants are lost, animals that feed on them go hungry.

Visitors' litter also poses a threat to animals. Park rangers recently reported that the tabs from pop-open beverage cans seem to be injuring many animals.

Some conservationists blame the National Park Service for ecological deterioration and other problems plaguing the parks. They say that the Park Service has encouraged more visitors than the parks can take.

What do the conservationists suggest?

They urge a strict limit on the number of visitors, particularly car-driving visitors, to each park. They say that most roads in and through the parks should be closed. Some conservationists urge a total ban on camper trailers in the parks.

Conservationists would like to have some wilderness areas of the parks kept off-limits to all visitors. These areas, they say, should be preserved for future generations. In their opinion, most other park areas should be accessible to hikers only.

The conservationists argue, "Let's keep the unique natural areas of the parks for those who want to get off by themselves in the wilderness and refresh mind and spirit away from the multitudes, attractions, and problems of the cities. The people who want only outdoor fun or a cheap camping vacation along the roads should seek it in other places."

A great many people disagree with this statement. "Who's to say who is qualified to enjoy nature?" they argue. "Just because some people don't want to go tramping through the woods, does that mean that the nation's beauty spots should be off-limits to them?"

Park Service officials tend to agree with this viewpoint. They say that access to the national parks should not be limited to a few "self-selected nature lovers." They believe that natural beauty should be seen by "windshield sightseers" as well as by hikers. The officials also contend that camping facilities should be provided for people who are not "rugged outdoorsmen."

However, Park Service officials are concerned about preserving the parks for the future. Therefore, they've recently taken steps to limit the flood of visitors into certain park areas. Private cars have been banned from parts of beautiful Yosemite Valley. Some roads and parking lots have been ripped up. A few areas of the valley can now be reached by free bus service. But many areas that used to be open to cars can be reached only on foot.

About 250 cabins have been pulled down at Yellowstone National Park. And the number of camp sites there has been sharply reduced. Some bypass roads are being built to keep car traffic away from the more popular attractions of the park--Norris and Old Faithful geysers.

Trailer campers have been banned from the Mesa Verde National Park in Colorado.

Despite these efforts, conservationists say that there are still too many roads, cabins, lodges, camp sites, and people in the parks. They say that the Park Service's efforts to prevent park overuse are too little and too late.

On the other hand, some park visitors are furious over new restrictions on use of the parks. One man said, "Each year I look forward to spending a week in Yosemite with my trailer, and, by George, I don't want any government official telling me I can't do it."

Caught in the middle, the National Park Service has a difficult double task. They are expected to keep the parks as natural and as unchanged as possible. Yet they're also expected to make the parks available to the people. These two goals produce constant conflict.

And no matter what Park Service officials do, they're bound to displease someone.

What would you do if you were running the U.S. National Park system?

--Michael Cusack

Questions

1. Why do people want national parks?
2. When was the national park system started?
3. How has use of the national parks changed over the last fifty years?
4. Why do some people think our recent "success" in using national parks is really a disaster?
5. What kind of problems are developing in the national parks?
6. What is the conservationist's point of view on using national parks?
7. What are the results of ecological deterioration?
8. Why do some groups wish to create "off limits" areas?
9. What step is the Park Service taking to help handle the people problem?
10. How would you recommend we use our national parks?

GARLIC - Herb That Kills Insects*

by Malcolm Weiss

What cures toothaches, mouse bites, snake bites, poisoned arrow wounds? And scares off demons, witches, and vampires besides?

Garlic.

Is there any truth to some of these ideas? Can garlic be used for something besides spicing up a recipe?

Maybe. The histories of most of the world's peoples are filled with what is called folk medicine, or what might be called "folk chemistry."

Sometimes, folk medicine has come up with a medicine years or centuries before science "discovers" the very same medicine. Take, for example, the tranquillizer called rauwolfia. It's made from a plant. Doctors in the U.S. and Europe have prescribed it--for only about 10 years--to "calm the nerves" of patients who have worries and problems that they can't seem to handle without a calming medicine. Yet--a thousand years ago--the Hindus of India used the rauwolfia plant for the same purpose.

So what about garlic? Its value as a "cure" for toothaches, bites, and wounds has yet to be proved.

But scientists have discovered that garlic kills the larvae of some insect pests! Larvae are insects that have recently hatched from their eggs.

A few years ago, scientists found that garlic was deadly to the Colorado potato beetle. Many insects go through four life stages--egg, larva, pupa, and adult (imago). Usually, insects in the larvae stage are always eating. This is true of the potato beetle. It is also true of mosquitoes. Legless mosquito larvae, sometimes called "wigglies," live in pools and ponds, feeding on miscroscopic life. Later, the adult females fly off to suck blood, and when they do that, they spread discomfort and, often, disease.

Mosquitoes are the target of two doctors in India: S. V. Amonkar and A. Banerji. The doctors work at the Bhabha (BAH-bah) Atomic Research Center in Bombay.

Mosquitoes are a major pest in India. Billions are born in the tropical climate, and they help to spread a variety of diseases, including malaria.

Until recently, use of DDT and other man-made chemical insecticides has been the main method of battling mosquitoes in India. But some mosquite species have become resistant to such chemical insecticides. What's more, there is a lot of evidence that DDT may be harmful to larger animals, including human beings. In fact, the use of DDT was banned in the United States, as of December 31, 1972, for all but a very few purposes. So scientists are looking for insect-killers that could be substituted for DDT.

What led Drs. Amonkar and Banerji to investigate garlic as a mosquite-killer? Two facts: First, the researchers knew that garlic had already been found to kill some other insect larvae, such as the Colorado potato beetle. Second, garlic had been tested out over thousands of years--"taste-tested," you might say--to be harmless to human beings.

*Reprinted from Science World, Pages 6 - 7, November 13, 1972.

The doctors collected some garlic cloves (the button-like sections of a garlic bulb). They pounded the cloves into powder. Then, they steamed garlic oil out of the powder.

When the researchers had enough oil, they began adding different amounts of it to water that contained mosquito larvae. "How much garlic," they wondered, "would be needed to kill the larvae?" Results: As little as three parts per million(PPM) of the oil killed 64 percent of the larvae! And just five PPM killed 100 percent!

Next, the doctors asked themselves: what was it in the garlic oil that was killing the larvae? To find out, they first had to separate out the various substances that make up garlic oil. They turned to one of the most useful laboratory techniques for separating mixtures of different chemicals--chromatography (crow-mah-TOG-rah-fee).*

The Indian scientists used silica gel to separate garlic oil into various substances. Silica gel is a coarse, white, sandy substance that absorbs wet substances very quickly.

As Drs. Amonkar and Banerji watched, six distinct layers "separated out" of the garlic oil. Which layer or layers contained the substance that was a deadly mosquito-killer?

By careful testing, the two researchers eliminated four of the six substances. The remaining two--both sulfur compounds--proved deadly to the mosquito larvae.

But then came a real surprise. Those two sulfur substances proved to be no more deadly than the whole garlic oil! That is, they weren't any deadlier when they were "pure" than when they were mixed in with the other four substances.

So it all seems to add up to nature handing man a pest-killer--on a platter(?)

Questions

1. What is folk medicine?
2. Was all folk medicine useless?
3. How did the garlic affect the potato beetle?
4. Why do we no longer use DDT for an insect spray?
5. What part of the garlic was used for spraying the mosquito larvae?
6. What does PPM stand for? Where have you seen this before?
7. How much garlic oil was needed to kill the mosquito larvae?
8. How many different substances did the scientists find in the garlic oil?
9. Which of the substances was responsible for killing the larvae?
10. Is the garlic oil considered a safe insecticide? Why?

*See Chromatography activity in Appendix E to demonstrate this process.

FIRST-AID FOR SICK TREES*

Droopy leaves, strange bumps, rotting limbs--what's wrong, what do you do?

Those shade trees in the yard lend beauty and value to your property. When all goes well, you enjoy them without a second thought. But when leaves wither, discolor or fall unseasonably, when branches die or galls pop out, the question is: can the tree be saved?

Just as with humans, disease or injury in trees may range from the simple to the serious. Drooping foliage, for example, may mean a tree is simply thirsty. Or it may signal the presence of deadly wilt. Galls - those unsightly lumps that sometimes show up-may be of a kind that are seldom harmful to the tree or they may be growths that harbor dangerous insects. Yellowing leaves may be a mark of too much moisture or not enough iron in the soil. Before you act to correct the situation, you need to know whether your trees are experiencing a temporary setback or are really calling for help.

Diseases. Your tree may have a sickness that affects only the foliage or one that strikes at its whole system, including the roots. Leaf diseases-particularly powdery mildew, leaf spot, leaf blotch, and leaf blight-are mainly caused by fungi. You can often tell them by the kind of damage they produce.

Powdery mildew is usually little problem and can be controlled with sulfur sprays. Leaf spot diseases often occur first as small, scattered circular or oval areas. They may enlarge and merge into irregularly shaped areas bordered in purple or reddish brown.

Leaf blotch diseases often show up as brown areas with yellow on the edges. The blotches may be limited to the margins of the leaves or to tissues between the veins or they may affect the whole leaf, causing it to turn brown and fall earlier than normal.

If your tree has caught one of the more serious blight diseases, leaves will probably turn completely brown or black, then die. Packets of liquid may appear on the ribs and veins of leaves, as well as on twigs and young branches. When large areas are affected, the tree itself may die.

Sprays will control most leaf diseases, but don't start spraying at the first sign of spots. Leaf diseases don't generally threaten the life of the tree unless infection causes leaf loss several years in a row. Leaf diseases are more common but less serious in deciduous or broad-leaved trees than in conifers.

If your tree looks as if it's suffering from something more serious than leaf illness, maybe it has caught one of the diseases known as wilt. Most of these are caused by fungi, a few by bacteria or viruses. Symptoms are drooping, curling and browning of leaves. In maples you can sometimes spot one common type by tell-tale green streaks that show up when you prune or cut away a branch to expose the sap wood. A ring of brown dots in a cross section of an elm branch is a sign of the usually fatal Dutch elm disease. If you do suspect that the trouble is one of the wilts, call on expert help, probably your only chance of saving the tree.

Insects. Troublemakers can often be identified by the kind of damage they do. Beetles, bagworms, caterpillars, cankerworms, sawfly larvae and webworms, for example, chew holes or eat whole leaves. Several species of insects called skeletonizers eat leaf tissue, leaving a lacework of veins. Miners gouge out channels between the upper and lower leaf surface; lacebugs, leaf-hoppers, aphids and scale insects suck sap and may discolor leaves. Scale insects attack a variety of trees and may be so

*Condensed from Changing Times, Pages 33 - 35, September, 1973

small you'll need a magnifying glass to see them at ground level or powerful field glasses to spot them on higher branches. Look for holes in the bark that might reveal the presence of borers and bark beetle larvae. Bark beetles and borers attack the trunk and limbs and are likelier to invade trees weakened by leaf-eating insects, disease, or injury.

The best defense against insects is to keep your trees healthy and growing. Fertilize them well and prune away weakened and dead branches where insects can hibernate and breed. Some sprays are effective against insects, but be sure you match the chemical to the culprit and do your spraying when the offending bugs are most affected by the spray.

Food and water. Malnutrition and lack of moisture can affect the growth and appearance of trees. If you have a tree on which foliage has turned yellow and begun to curl, the trouble may simply be lack of iron. The condition can be reversed by a dose of iron supplied to leaves or soil or injected into the trunk.

A similar-appearing condition is caused by flooded roots. The solution in this case is better drainage, not iron shots. So beware of hasty diagnosing. You'll need to check all conditions around the tree before you can settle on what's wrong with it.

The elements. In winter, ice and wind can topple trees and break limbs. In summer lone trees or tall trees with roots spread wide in moist soil are susceptible to lightning. If such damage occurs, hanging or shattered branches should be removed lest they become a breeding place for insects and disease or a safety hazard.

Wood fibers are weakest where branches join or trunks divide, and that's where wind, ice, or the weight of a crop of healthy leaves often cause trunks and branches to split. Bracing gives support and eases pressure at critical points. If you don't know how to do it, better get professional help.

Where to get help

Your county agricultural agent, extension landscape specialist, or state agricultural experiment station can help with the diagnosis of tree troubles and probably recommend treatment.

If you seek advice by phone, be ready to give a good description of the tree's condition. Your answers to questions like these will help with the diagnosis: Has there been any digging near the tree or has the grade level around it been changed? When did you first notice the problem? Has lawn fertilizer containing weed killer been applied recently? Are nearby trees of the same species affected?

For a price, professional tree-care outfits will fertilize, spray, prune, brace a tree, or take one down. These tips will help you avoid the quacks:

--Be wary of "tree experts" asking for business door to door. Good ones usually don't operate this way. They have plenty of work as it is.
--A tree expert should have a place of business. Check his reputation with the Better Business Bureau and customers who've used his services.
--Inquire about his professional status. Affiliation with the National Arborist Association means he has access to a course of training on tree care. Qualified members get a certificate. Membership in the International Shade Tree Conference or local Nurserymen's Association are also clues to his standing.
--Ask him to explain the diagnosis, treatment, and price. If the problem looks pretty serious, you're better off with the expert who admits he doesn't know what to do than with one who vaguely prescribes a "general spraying and feeding."

--Ask about insurance. Reputable firms carry it on your property and their crews. A fly-by-night outfit that's uninsured could damage your house if he accidentally dropped a tree on it and you pay the cost to fix the house.
--Note the equipment. Amateurs often carry common hand tools. Professionals will have special tools and safety equipment, including government-required hard hats and breathing respirators if spraying is involved.

Questions and Activities

1. Name three tree diseases caused by fungi.

2. Is any tree completely disease free?

3. Why should you not start spraying at the first sign of disease?

4. If a tree is thirsty what will happen to it?

5. What causes the galls or lump that sometimes appear on tree leaves and limbs?

6. What signs would you look for if you suspect Dutch elm disease?

7. What's the best defense against insects damaging trees?

8. Why should dead or damaged limbs be removed from your trees?

9. Do trees need iron?

10. What should you do if you think something serious is wrong with your trees?

11. What are some ways to tell good tree experts from poor ones?

12. Examine trees in your yard and neighborhood to see if they have any signs of disease or damage that should be checked by an expert.

13. Write to: Illinois Natural History Survey, Natural History Building, Urbana, Illinois 61801 for a list of materials they have available covering tree problems.

14. Write to: Information Officer, Northeastern Forest Experiment Station, 6816 Market St., Upper Darby, Pa. 19082 for a single copy of the pamphlet Our Air - Unfit for Trees which tells which trees are affected most by air pollution.

15. Visit your local County Agent office and find out what kinds of information they have available about trees. Also ask what kind of services they can provide to owners of trees.

16. Visit a wooded area and collect various kinds of tree leaves and tree twigs (12" pieces of the ends of tree limbs). Do not take tree twigs from small trees or other people's trees without permission. After collecting the leaves and/or twigs, compare them and label each after identifying it.

DUTCH ELM DISEASE-ON THE SCENT OF A CURE*

Elm Street, U.S.A. At one time this name could have described a tree-shaded avenue in many a city and town in the eastern half of the United States. But not anymore.

The stately elms are dying. Thousands of elms across the nation have already been struck with a deadly disease imported from Europe. It's called Dutch elm disease. The disease is caused by a fungus--a simple nongreen plant. (This group of plants includes molds and mildews.)

Scientists first detected Dutch elm disease in the United States in Ohio, in 1930. No one is sure, though, how it spread from Europe to Ohio. One thing scientists do know: unless someone comes up with a cure or a way to prevent the disease, our elms might become extinct!

How does the disease spread from one elm to another? The fungus, known as Ceratocystis (SAIF-ah-toe-SIS-tis) ulmi, can spread under the soil from the roots of a diseased elm to the roots of a healthy one. But most often, a certain beetle, called the smaller European elm bark beetle, carries the fungus with it from tree to tree. How?

When male and female beetles are ready to mate, they "set up house" in a diseased or dead elm. There, female beetles burrow tunnels in which they lay their eggs. If the trees were alive and healthy, newly hatched beetles would be pushed out by the water and sap in the tree.

After young beetles hatch and mature, they leave the diseased elm and fly to a healthy elm, carrying the Ceratocystis ulmi fungus with them. Only from a healthy elm can the beetles obtain the food they need. But when these beetles are ready to mate, they also must fly to a diseased elm, as their parents did. Each time a beetle moves from a "sick" tree to a healthy one, the beetle spreads the deadly fungus disease.

Now you are probably saying, "To stop Dutch elm disease, why not destroy all the beetles with an insecticide?" Think again. What have we learned about the effects of using chemicals to get rid of unwanted pests?

A group of five scientists has learned from the mistakes of others. They are looking for a safe, nonpolluting means of saving our elms.

Two of the scientists in this group, Dr. John W. Peacock and Dr. Charles Lincoln, are from the U.S. Forest Service Station in Delaware, Ohio. The other three scientists, Dr. John B. Simeone, Dr. Robert H. Silverstein, and Dr. Gerald H. Lanier, are from the State University College of Forestry at Syracuse, N.Y. All the scientists are entymologists (insect experts), except Dr. Silverstein, who is a chemist.

Your Science World reproter made a trip to Syracuse to see and learn about the work these scientists are doing.

Dr. Silverstein and Dr. Simeone brought us up to date on their Dutch elm research. When they started this project, they were aware that at the time of mating, beetles fly to a diseased or dead elm. The researchers assumed that there is something in these elms that attracts the beetles. And they guessed that it is an odor given off by the tissues of these trees.

*Reprinted from Science World, Pages 3 - 5, 17, October 4, 1971.

But the scientists were more concerned with another phenomenon they had observed. Once a few beetles burrow into an elm, many more beetles come winging to that tree than to any other neighboring one.

To track down what makes for such a beetle invasion, the researchers carried out several field studies.

First, they cut down diseased elms. Then they cut the trunks of the elms into logs three to five inches in diameter and 18 inches long. The scientists waxed the ends of the logs so that the moisture and the gasses in the wood would not escape. Then they wrapped a plastic screen full of tiny holes around each log.

The researchers divided the logs into four sets of four logs each. In reality, these were beetle traps. You'll see why later. Next, the scientists added laboratory-grown beetles to each of the traps. The plastic screen kept the beetles from escaping. Finally, each bundle of logs was surrounded by chicken wire that had been smeared with a sticky substance.

However, each bundle differed from another in an important way. Bundle One contained female beetles that had not mated. Bundle Two contained male beetles that had not mated. Bundle Three contained male and female beetles that could mate with each other. The fourth bundle acted as a control. It contained no beetles at all.

The bundles were set out in an open field. Then the scientists waited. After 24 hours, the researchers examined the sticky chicken wire. Some wild beetles had been lured to each bundle and trapped on the wire. But how many in each case?

About the same number of beetles had been snared by the wire of Bundles Two and Three. The smallest number of beetles were attracted to Bundle Four. But the wire of Bundle One was crowded with from five to ten times as many beetles as had been trapped by any of the other bundles. What's more, many more males than females were trapped in Bundle One.

This means that the odor from a dead or diseased elm, combined with that of a substance produced by unmated females, brings beetles on the "run" to infected elm trees.

In order to find out more about the substances that lure beetles to elms, the researchers have brought their studies back into the laboratory.

What will happen once the scientists know what the chemical compound is? (They know it is one of a family of substances called pheromones.) The researchers can then make the compound in their laboratories, and use it to decrease the number of beetles that spread Dutch elm disease.

How? The artificial pheromone might be used to attract male beetles to special traps and keep them away from the elm trees. Some of these males might then be sterilized. They could still fly around, but they could not "father" any young.

The scientists are not trying to kill all the elm bark beetles. According to Dr. Simeone, that would be almost impossible. But if they use an artificial pheromone to attract beetles away from elms and sterilize some of them, the scientists will have come up with a non-polluting and safe way of gradually eliminating Dutch elm disease.

--Joan Schuman

Questions and Activities

1. Has Dutch elm disease always been in the United States?

2 What are the two ways by which the disease can spread?

3. Why do the European elm bark beetles lay their eggs in diseased or dead elms instead of healthy elm trees?

4. Why do the newly hatched beetles travel to healthy trees?

5. What actually causes the Dutch elm disease?

6. Why are people concerned about Dutch elm disease?

7. Why do we not kill all the beetles to control the Dutch elm disease?

8. What kind of research did the scientists conduct to find out what attracted beetles to dead elms?

9. How do scientists hope to control the Dutch elm disease?

OH! WHAT A GARDEN!*

By Josephine Van Dolzen Pease

The whole Earth is an enormous, tremendous, stupendous garden where a million-times-a-million plants grow.

Water plants floating in the water. Air plants trailing in the air. And on the land, grass and trees and flowers of every color and a million-times-a-million plants more!

Forests and forests of trees grow on the Earth. Different kinds of forests where the evergreens sparkle like Christmas trees in the snow and little birches shine silver in the sunlight. There are forests that flame with red and gold in autumn and drop ripe nuts on the ground.

In the jungle forests near the Equator, palm trees grow taller and taller in a summer that never ends. The leaves of the banana trees spread wider and wider over bunches of yellow bananas. Coconuts ripen sweeter and sweeter in the hot sun. Twisting roots and winding stems tangle the ground. Vines loop from tree to tree. And in some forests near the Equator, rubber trees grow.

On some deserts, beautiful strange cactus plants grow.

Cactus plants are not troubled that it almost never rains in their desert home. They store up water in their stems from one far-off rain till the next and bloom with flowers when all the desert is hot and dry. And they grow sharp thorns so no animal can come nibbling for his dinner!

*Reprinted from Wide, Wonderful World, Pages 6 - 7, Grolier Inc., New York.

Activity: Have students draw pictures illustrating the various scenes verbally described by the author.

THE STORY OF CORN*

By Maud and Miska Petersham

Ever since the long-ago days, so long ago that we cannot tell how long, a very tall, strong grass called corn has been the special plant of the Indians. In the old days the Indians treasured it above all other things, because in summer and in winter it gave them their most important food.

It was from the Indians of the Americas that the world learned to know this corn plant which we call Indian corn or maize.

The Indians believed that in the beginning maize had been given to them by their gods, and different tribes had different stories of how this had come about.

Once the Great Spirit came down to the earth in the form of a beautiful woman. She fell asleep, and when she awoke she walked through the land. Useful plants began to grow all about her, and wherever her feet touched the earth tall waving stalks of green corn appeared.

From his great teacher, Nature, the Indian learned much wisdom to help him in his task of planting and tending his corn and bringing it to harvest. He knew the planting time and the harvesting time from the trees and flowers about him. In the spring, when the oak leaf uncurled to the size of a mouse's ear, the Red Man had learned to plant his corn.

He dug holes in the earth with a pointed stick or with a clumsy hoe. The hoe was made by fastening a stick to a clam shell or to the shoulder bone of a buffalo or a deer. Even the antler of a deer was tied to a stick and used as a hoe.

He placed the finest kernels of corn in the holes as seed and covered them with earth. In order to make the soil richer, some Indian tribes dropped a small fish or a crab into the holes which they had dug and then carefully placed a few kernels after it.

In a short time the tender green shoots appeared and then it was the work of the Indian squaws to keep the growing corn free from weeds and to hill up the earth about the stalks. The different families of the tribe came together and planted their corn in great fields which were owned not by one man but by the whole tribe.

In the middle of the fields, perched upon sticks, a little platform or watchhouse was built. Here on this platform an Indian boy or girl was always watching. In the early morning and all during the day, it was their duty to drive off the crows and the flocks of hungry birds which hovered about.

If enemy tribes were near, sentries were placed all around the cornfields to guard the men and women working in them.

After the planting time was over, most of the tribe set off for the summer hunt. Some of the women and the children were left to care for the corn in the fields. But when the hunters saw that the blazing star, a weed which grew in the land of the Middle West, was in flower, or that the cattail or goldenrod was blooming, they knew that the cornfields at home were ripening. They knew it was time to return for the roasting ears and for the harvest.

*Reprinted from Wide, Wonderful World, Pages 60 - 66, Grolier Inc., New York.

It was not until Columbus made his first voyage to America that the rest of the world learned about corn. Columbus told Queen Isabella of the waving cornfields of the Indians, and of the good things to eat that the Indians knew how to make from corn. He did not know that when the first white men came to make their home in the New World this same Indian corn would save them from starvation.

The earliest settlers in Virginia were among the first white people to find this out. The little settlement was having a hard struggle to exist. With all the working and planning and saving the people were able to do, their food was at last all but gone. Nothing to eat! All about them only the strange wild forest and the unfriendly Indians. Weary and sick and in despair they decided to give up and go home.

But Captain John Smith, their leader, was not willing to see his brave people defeated by hunger. He looked about him. "How do Red Men live in this wild country?" he asked himself. "They are men like ourselves, and must eat." The answer was plain. The Indians were living on corn!

"If we can get some of this corn, we also can live," he said to his people. By trading with the Indians he was able to get a supply of corn, and the lives of the settlers were saved.

As the number of white people grew greater and greater in the East, more land was needed. Pioneers who moved westward found that the soil in the valley of the Mississippi River was especially good for the growing of corn. Large crops of it were raised until the time came when there was more than enough for the families and their cattle.

In those days of bad roads and no railroads it was very hard to send the extra corn from one place to another. But it could be fed to the cattle and the cattle could be driven back to the East in great droves and sold for food.

Then came railroads and highways. Raising cattle for food became important. The great business of storing up quantities of meat for sale was started. Now, most of the corn is raised, not to feed men, but to feed pigs and cattle, which then become food for man.

In their great task of settling America, men cleared the wilderness and tilled the soil with only a few simple tools and their own strong hands for the work.

Then the time came when all over the world machines were being invented to take the place of hand labor. Many of these machines were for the help of the farmer, and wherever they went they brought a new kind of farming to the world.

Today a plow of steel and iron breaks up the land for the farmer. Great machines help him plant and cultivate and harvest his corn crop. One machine can cut long rows of stalks and tie them up into shocks in a few moments' time.

Another machine, called a corn picker, travels up and down the rows of ripened corn, picking off the ears and dropping them all husked into a wagon which it drags along beside it.

A silo, or great, tall, round tank, is built today on many farms. Much of the corn is never husked, but is cut when green, mixed with other foods, and stored in the silo. The cattle may still have green food although the pastures are white with snow.

As machinery improved, more corn could be grown. Today it is raised all over the United States, in Canada, the Philippine Islands, and in Mexico. Even in Europe and in Asia corn has become a valuable crop, although in the Old World it has never taken the place of wheat and rice.

Three-fourths of the corn of the world is grown in the United States. The strip of land in the Mississippi Valley, where it grows best, is called the Corn Belt.

Some men have been working to make better machines to use in the cornfields. Other men have been working to produce better corn plants.

The Indians had several kinds of corn. They had corn with ears of many colors, some red, some blue, others yellow, others black or spotted. The White Man grows several different types of corn, but most of his corn has white or yellow kernels.

Sometimes the corn plants become dwarfed and sickly and bear but little. Plants can be hungry and starving, just like people.

Farmers and scientists have worked in many ways and have studied with each other to find out why this happens. After years of trying and many failures, men have learned some of the things that make healthy, sturdy plants.

They have even discovered how to take two different types of corn plants and produce from them a new plant, stronger and better than either of the other two.

There are now many schools of agriculture and many trial farms. With their help the farmer who grows corn today can learn how to get the best and the most from his field.

Like the Indian, the White Man makes meal from kernels of corn and this meal, or flour, is used in many kinds of cakes and breads. He also eats green corn, both fresh and canned.

The people living in the southern part of the United States eat a great deal of both hominy and ground yellow corn, and in Spanish America corn is the chief cereal used.

Many fine breakfast foods are now made from corn, and corn syrup has taken the place of maple sirup on many a breakfast pancake. An oil used in cooking is also made from corn.

Besides food in different forms, the corn plant gives us many other useful things. Thousands of bushels of corn are used every year in the making of glucose and starch. The paper you write on may be made from cornstalks. Cornstalks are also made into a cloth which looks like silk, and into a kind of wallboard used in building.

It is not, however, in the form of Johnny-cake or breakfast food or starch that we value corn the most. It is in the form of meat from the cattle and hogs that are fed with it that corn performs its greatest service to mankind today. For corn is the best food for livestock that men have ever known.

In feeding the meat-animals of the world, men are also fed. Maize, the gift of the Indian to the White Man, has become of great importance in the world.

Questions and Activities

1. Which group of people first used the corn plant?
2. Is corn a kind of grass?
3. What is another name for corn?
4. What natural sign told the Indians when to plant his corn?
5. What kind of tools did the early Indians use to work the soil when preparing it for the corn seed?
6. Why did some Indians place a fish or crab into the hole with the corn seed?
7. Did the Indian man or woman care for the corn fields?
8. Why was an Indian boy or girl placed on a platform in the middle of a field?
9. What natural signs told the Indians that their corn was nearly ready to harvest?
10. When did the rest of the world first learn about corn?
11. Why was corn important to the early settlers?
12. Where did the settlers find very excellent soil for growing corn?
13. What happens to most corn grown in the United States today?
14. How have machines changed the raising and using of corn?
15. Where is the corn belt?
16. How much of the world's corn supply is grown in the United States?
17. What are some foods we get from the corn plant?
18. What are some things other than foods than can be made from the corn plant?

PLANTS HELP CONTROL POLLUTION

People often take plants for granted. We expect the plants to be here, but seldom think about the many ways plants help us. In addition to producing food and oxygen, plants can help control erosion, lower noise levels, clean pollutants from the air, block out unpleasant sights, provide privacy, alter winds and temperatures, and add beauty to areas which could affect our attitude.

Regardless of how we might use plants in solving environmental problems, we need to understand the potentials and limits of various plants. We should also determine the factors causing the environmental problems. For instance, if plants are to be used to control soil erosion, a plant should not be selected that produces little ground cover or has a small root system. Of course plants grown to reduce air pollutants should be able to resist the pollutants. Plants with large amounts of foliage are good for reducing noise pollution.

Deciduous trees are very useful plants for modifying temperature. The leaves during the summer tend to screen out the sun's rays helping lower the temperature. During the winter, the sun's rays can pass through the branches, thus providing a warming effect. Evergreens can be used to get the opposite effect during the winter. Snow melting on ski slopes can be slowed by proper placement of evergreens, allowing the skiing season to be extended.

One of the problems associated with our increasing population is the difficulty of finding privacy. Privacy in the home can often be obtained through proper planting of hedges around the yard. Foliage plants used in hedges can also screen or block from view such ugly sights as junkyards and trash dumps.

Noise is becoming a greater and greater problem. Research has shown that materials that are light, porous, and flexible are the best for absorbing and reducing noise levels. Plants that have these characteristics will therefore most likely be the best for reducing noise levels. Such plants will have thick, fleshy leaves with thin stems. The soft parts of plants absorb sounds while the larger branches and trunks of plants scatter or break up sound.

Plants clean the pollutants from the air by taking some of the harmful chemicals directly from the air into their tissue and by acting as filters onto which small particles can collect. Rain washes the collected particles from the plants onto the ground. Carbon dioxide, one of the waste materials from burning fossil fuels, is used by green plants in the process of photosynthesis.

For a long time man has used plants to cover farmland and to make shelter belts. One of the purposes is to lower the rate of soil erosion caused by water and wind.

Questions and Activities

1) Why has there been little research into ways of using plants to control air and noise pollution?

2) How can city planners better take advantage of the various uses of plants?

3) How can plants be used to cool your home during the summer?

4) Would it be a wise choice to plant a large evergreen on the south side of your home?

5) What type of plants would one use to control soil erosion?

6) Do all plants work equally well in reducing air pollution?

7) What kind of plants would you plant around a salvage yard?

8) Would evergreens or oak trees be better if one wants a plant to help reduce noise?

9) Make diagrams illustrating various ways plants can be used to reduce various types of pollution.

10) Find library books explaining ways plants can reduce pollution problems.

APPENDIX E

Student Projects and Miscellaneous Reference Materials

Grass Weaving. E-2

Grow a Pineapple Plant E-3

Fruit Trees Grow Indoors E-4

Three Dimensional Pictures Using Dried Flowers E-5

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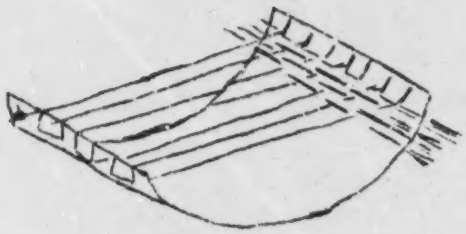

GRASS WEAVING*

By Elizabeth Darlington

The stems and leaves of grasses are used around the world for fuel, building material, and for thatching. Chinese peasants wear straw capes and wide hats in the fields to keep off the sun and rain.

You may not be able to thatch a hut, but you can weave a small mat as a sample of a very ancient craft.

You will need:

Cardboard, stiff but bendable, 2 " longer than the mat you plan, but the same width
Carpet thread, kite string, or fish line
Straw or native grasses soaked a short time in water

Cut slits on both ends.

Cut 1/4" slits in each end of the cardboard, 1/2" apart. Knot your thread (the warp) and thread your loom as shown in the picture. Keep the threads taut as you go by bending the cardboard. When you have finished, tie your last warp thread to the loop next to it.

Starting at one end of the loom, weave a strand over and under, the next strand under and over, and so on. Push the grass blades tight together with your fingers as you go.

When you have finished, trim the sides of the mat, and weave a few extra threads along the sides for strength. Then slip the mat off the loom, and weave a few extra pieces of grass into the loops.

Experiment with different grasses. Wheat straw is the best, if you can get it. Have patience--and have fun!

*Reprinted from The Curious Naturalist, page 15, September, 1973.

GROW A PINEAPPLE PLANT*

By Naomi S. Myrvaagnes

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You have never found a seed in a pineapple. This seems strange after having a peach, apple, or cherry, doesn't it? Commercially grown pineapples have been bred to be seedless, like some types of oranges, because seeds ruin the fruit for canning. Without seeds, how can you grow a pineapple?

When you enjoy the sweet but tangy flavor of a juicy, fresh, aromatic pineapple, you normally discard the tough, spiky skin and the pleasant green leafy crown. However, if you remove this crown and plant it you can grow your own pineapple plant. The plant only grows to three or four feet high, so it makes an excellent house plant.

When you remove the crown, be sure to leave no fruit at all as it will, when planted, cause the whole crown to quickly rot. The crown may be cut, or if the fruit is soft where the crown joins the fruit, it may be broken off with a snap right where it joins the fruit. However, before buying a pineapple you intend to grow, first check to see if it has a healthy medium to dark green crown of good stiff leaves without any missing from the center of the crown. (Shoppers frequently pull out a center leaf to test the ripeness of the fruit.) There is one certain variety that is most suited to house culture. This variety is called Smooth Chayenne (pronounced Keye-en') and may be easily recognized by the almost total lack of hooks on the edges of the crown leaves.

After eating your pineapple, prepare the crown as shown in the diagram. The crown may be planted right away, or left to sit in a shaded area for one or two days to dry cut areas. This lessens the change of rot. A 4" pot is best to start the crown in. When it gets larger, it may be transplanted to a 6" pot.

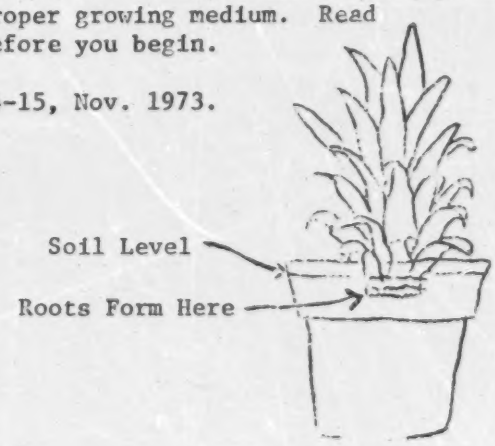
Break off top. Take off lower leaves leaving 1/2" core. Dry 1 or 2 days before planting

A special mix should be prepared for your plant consisting of 1/2 part coffee grounds (or used tea), 1 part peat moss, and one part sand. The coffee or tea residue will raise the acidity of the soil, a condition in which pineapples thrive. The peat moss will also make the soil more acid. The sand, however, is mainly for fast drainage essential for the good growth of the pineapple plant. This requirement of fast drainage the pineapple gets from its Bomeliad heritage.

After planting, the pineapple needs little care. Give it good sunlight, moderate waterings, and a spraying once every two weeks with house plant fertilizer (1/4 strength) in water. (A Windex sprayer bottle works fine.)

You can grow a whole assortment of tropical plants, many of them from the seeds of fruits you have eaten. Citrus fruits are probably the most common in your household so start with an orange, lemon, or grapefruit. The only materials you really need are the seeds, a few pots with a drip catcher under them, and the proper growing medium. Read up on how to prepare and care for each plant before you begin.

*Reprinted from The Curious Naturalist, page 14-15, Nov. 1973.



FRUIT TREES GROW INDOORS*

Interior decorators are now using mature orange and other kinds of citrus fruit trees in indoor gardens. These trees with their glossy, dark green foilage are perfectly stunning with flowers and fruit on them.

Of course, they are too big and probably too expensive for the average home. But small ones also can be attractive and it is possible to start them yourself from the seed. It takes time to get them to any size but it can be fun watching them grow.

Seeds taken from tangerine, grapefruit, lemon and orange bought in grocery stores can be used. Six or eight small tangerine or grapefruit plants in a small pot can make a very nice center-piece.

Plant three or four seeds in a three-inch pot or six or eight in a six-inch pot. For potting soil, use a 50-50 mixture of good soil and sphagnum peat (if you don't have it, use the potting soil for house plants sold in many supermarkets.)

Citrus seeds are injured by drying. Leave them in the fruit until time to plant. If that is impractical, put them moist in a plastic bag in the refrigerator until you are ready to use them.

Soak the seeds in lukewarm water for a day before planting. This may speed germination. Cover the seeds with one-fourth to one-half inch of soil. The seed bed should be kept moist but not soggy wet. A soil temperature of 70 to 80 degrees is best. Sprouting is delayed if the temperature is much below 70.

Usually it takes about six weeks for germination. Keep the pot in a shady place until the plants start to come up and then move them to good light, preferably some sunlight.

A coffee plant can make quite a conversation piece and it is fairly easy to start yourself if you can find some unroasted coffee beans. Even better are ripe cherries from a coffee plant growing in a botanical garden which sometimes can be had for the asking. Remove the pulp from the seed by hand. After pulping, put the seeds in a glass of water overnight. The next day wash them in clear water and plant at once.

Plant the beans in a 50-50 mixture of good soil and peat or in shredded sphagnum moss in a flower pot. Wet the moss thoroughly and then squeeze out excess water. Cover the beans with about one-fourth ince of sphagnum or soil.

If sphagnum is used, it is necessary to start fertilizing as soon as seedlings appear, usually in about eight weeks. There is no nourishment for them in the moss. Give them a weak nutrient solution every week. When the seedlings have four leaves, plant them in individual pots, using a mixture of good soil and peat.

Your coffee plant will require sunlight and should be fertilized lightly once a month during spring and summer. Water when the soil feels dry to your touch. Spray or sponge the shiny green leaves with water occasionally to rid them of dust.

In six to eight years a plant may produce fragrant white flowers and red cherries.

Date seeds also can be used to start house plants. Take the pits from dried dates as they come from your mouth and plant them the same way you would citrus seeds. Plant them horizontally with the navel up. They usually germinate in about three weeks. Transplant the seedlings to individual pots after they have grown about the fourth leaf.

Don't expect the dates to bear fruit. You'd have to wait until the trunk is about three feet across and 20 feet tall.

*from The Capitol Journal, Februray 17, 1974.

THREE DIMENSIONAL PICTURES USING DRIED FLOWERS

Flowers, as well as leaves, seed pods, and grass, can be dried and mounted to create a simple three dimensional display or an elaborate bouquet. The flowers can be gathered from your own yard or along roadsides and fields.

Materials needed: flowers, borax, small box (shoebox works well), spoon, small brush (the type used with water colors), tweezers (optional), scissors, stiff cardboard or large flat pan such as a cookie sheet, Elmer's glue, toothpicks, background on which to glue flowers, picture frame or border

Keep your box and borax with you when gathering flowers. Place a shallow layer of borax in the box. Gather a few flowers and place them in the box so they are not touching. Small flowers will probably be most desirable, but this depends upon the size of the finished picture.

Carefully sprinkle borax over each flower immediately after picking until completely covered. This must be done quickly as many flowers wilt within minutes after being picked. Remember that if a flower is crushed when sprinkled with borax it will be a crushed flower when dried.

Gather many more flowers than you plan to use as some will become damaged and you need a selection to choose from.

For drying, allow your box of flowers and borax to stand undisturbed for a minimum of three weeks.

At the end of the drying period, carefully spoon the borax into another container such as the original borax box, to expose the flowers. The borax may be kept and reused to dry more flowers. Remove the flowers and place on a piece of cardboard or cookie sheet so they can be moved easily yet stay undisturbed. Tweezers may be helpful in removing the flowers from the borax.

Each flower you use in the picture will probably need dusting with a small brush in order to remove excess borax.

Arrange the flowers into the pattern you want before attempting to glue. Flowers can be overlapped for a clustered appearance. Stems need to be closely cut from each flower. You may find that the petals of some flowers will separate from the center making it necessary to arrange some flowers petal by petal. If you wish stems in your arrangement, these need to be arranged separately from the flower.

The flowers may be glued on a sheet of construction paper and bordered, but this would allow it to be only a temporary piece of art as the flowers are very delicate. A more permanent display can be made by using a small picture frame with a convex glass or a larger picture frame with the glass positioned away from the back. A frame in which the back lifts out rather than slides out is more desirable. Black velvet glued to the back of the picture frame makes an elegant background on which to glue the flowers, but other materials may be used.

Carefully glue each flower into position using a small amount of glue on a toothpick. Tweezers may be helpful in holding the flowers.

When finished gluing, hold your arrangement upside down and gently shake to make sure everything is glued.

With the brush, dust any remaining borax from the flowers and background.

Take care when placing your arrangement in a frame as all your work could quickly be destroyed.

These could be used a gifts for Christmas or Mother's Day.

PAPER CHROMATOGRAPHY

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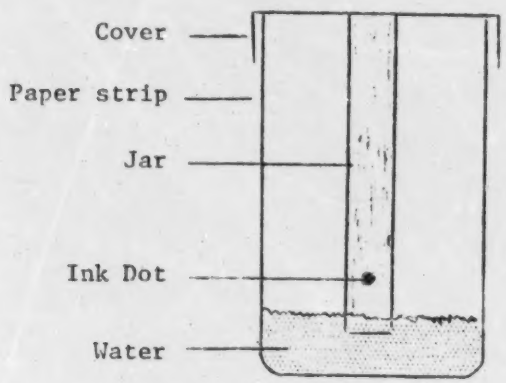
Chromatography is a relatively new tool for scientists. It allows them to separate small quantities of substances. Today, chromatography is widely used in studying the chemicals present inside plant and animal cells. Many of the substances found inside plants and animals are in such small quantities and are so similar that our older processes will not separate them. There are several complicated forms of chromatography, but one of the simple methods, paper chromatography, can be done by any student with easy-to-get equipment.

Once the basic steps are learned, many substances can be separated by using paper chromatography. The principle behind the process can be compared to the separating of different sized stones in a river bed. The lightest stones move the greatest distance, while the heavy stones travel only a short distance.

Materials needed for learning the process consist of (1) a jar or long test tube that can be covered, (2) any noncoated paper such as border from a newspaper, (3) some water, (4) some way to fasten the paper strip to the container top, (5) washable black ink.



Place a dot of the washable black ink on a narrow strip of paper about one inch from the bottom. Place about 1/2 inch of water in the container. Hang the paper strip inside the container so only the bottom edge of the paper touches the water. Do not allow the dot to get into the water in the container. Cover the container and watch what happens. The diagram will help you set up the material.

If no change occurs after thirty minutes, use a different set of materials and try again. After you have success with the ink, try using various other substances. Plant juices, other inks, paints, and assorted other things can be tried.

Think about and try to explain your observation. How can this process be used by people studying plants?

GROWING NEW PLANTS

Many new plants can be grown from parts other than seeds. For instance, some can be grown from stems, roots, or leaves.

(A) A sweet potato is a root of the plant that is greatly enlarged to store food. Not only do we enjoy eating this stored food, but the stored food can be used to produce new sweet potatoes. You can start new plants from the sweet potato by placing the pointed end of a sweet potato in a jar of water. In a few days, new root and stems should be visible. These are often used as house plants because of their full foliage and low maintenance requirements. When roots develop from the individual vines they can be removed from the old sweet potato and planted in the soil to produce new potatoes.

(B) Other vegetable roots that will grow into new plants include carrots, beets, turnips, and parsnips. Select one of the vegetables and remove any wilted leaves. Cut off about 2 inches of the upper or large end of the vegetable. Place this upper end upright in a shallow pan of water. You may need to add sand or pebbles to the pan to help hold the vegetable upright. Add water as necessary to replace any water lost through evaporation. In a few days, the root should produce new leaves.

(C) The Irish or white potatoes are stems that grow underground. They are not roots. Cut a small piece of the potato out that contains an eye or a bud. Plant the piece in a pot of soil, about 3 inches below the surface. Keep the soil moist and in about 2 weeks, a new potato plant will appear. This is the method farmers use to produce new potato plants.

(D) Another unusual stem is the onion and garlic bulb. By placing toothpicks into an onion or garlic bulb, the bulb can be held over a jar or glass of water so that only the bottom end of the bulb is in the water. In a few days, new roots and leaves will be formed.

(E) Collect pussy willow stems (about 12 inches of a branch) in the early spring. Place the lower end of these branches in a jar of water. In a few days new roots will form from the branches. After the branches have a good set of roots, they can be planted in soil. These "new trees" will continue to grow into trees just like the one from which the branches were cut.

(F) Make a cut across each of the big veins in a thick red begonia leaf. Place the leaf rightside up on a pan of damp sand. Lay a few pebbles on top of the leaf to hold it flat. Next, place a large jar upside down over the leaf. In a few weeks new plants will form at each cut. When these plants are about 3 inches tall, they can be separated and planted in soil.

Ways Indians Used Plants*

Anemone, Canadian
The root was one of the most valuable medicines among certain tribes. It was applied externally and taken internally; it was also used as a wash for sore eyes. It was called "Little Buffalo Medicine."

Arrowleaf
The tubers were used for food, prepared by boiling or roasting.

Artichoke, Jerusalem
The tubers of this were used for food, either raw or boiled.

Ash
Ash wood was used for making pipestems. It was used also for making bows and arrow shafts. Part of the sacred pole of the Omahas and Poncas is made of ash and part of cottonwood.

Ash, Prickly
The young Indian men used the fruits of this shrub as a perfume.

Bergamot, Wild
Horsemint: The flowers and leaves were boiled together to make a medicine used for abdominal pains. A liquid made from boiling the leaves was used for pimples and other dermal irruptions.

Black Current, Wild
Beaver Berries; a strong medicine was made from the roots and used for kidney trouble. The berries were eaten for food.

Blazing Star
The flower heads mixed with shelled corn were fed to horses to make them swift and put them in good condition.

Boxelder
This tree was used for sugar making by all the tribes. Charcoal was made from it for ceremonial painting and for tattooing.

Buffalo Bean
Ground Plum; The bean was put in with the corn kernels at the time of planting. This was an ancient custom, the origin of which is forgotten.

Buffalo Berry
The fruits were used fresh in season and also dried for winter use.

Bulrush
The tender white part at the base of the stem was eaten fresh and raw. The stems were woven into matting.

Burdock
A decoction of the roots of this was used for pleurisy.

*Reprinted from Science Activities, November, 1973, pgs. 33-34,46.

Chokecherry

A favorite food of all tribes. The fruit was eaten fresh or dried and made into cakes for winter use. Trappers washed their traps with water in which the bark of the chokecherry had been boiled to remove the scent of other animals and the trappers scent from the traps.

Clover, Purple Prairie

The leaves were used to make a drink like tea. The root was chewed for its pleasant taste. The tough, elastic stems were used to make brooms. As a medicine, the root, after being puverized, was put into hot water. After the sediment settled, the water was drunk to ward off diseases. The sediment taken from the water was buried with respect.

Clover, Sweet

This was introduced by the White Man. The Indians liked the odor and gathered it in bundles to hang in their home.

Columbine, Wild

The seeds were used as perfume by bachelors and the seeds were crushed into a powder, put into water and used as a medicine.

Cottonwood

The peeled young sprouts and inner bark were eaten for food because of its pleasant taste and nutritive value. The wood and bark were used as fuel and a yellow dye was made from the leaf buds in the spring.

Cucumber, Wild

The seeds were used for beads.

Dogwood, Red

The outer bark was removed after which the inner bark was scraped and dried for smoking. It is fragrant and all tribes were very fond of it.

Elm, American

The wood was used for fuel, corn mortars, pesties, and for posts for earth lodges.

Four O'Clock, Wild

The root was boiled to make a medicine for killing worms in the body and was also used to reduce swelling of a part of the body. The dried root, ground up fine, was applied dry as a remedy for sore mouth in babies.

Fox Glove, Wild

A decoction of leaves taken internally was used for chills and fever.

Goldenrod

This plant served as a mark in the Indian's flower calendar. This plant blooming signified the ripening of the corn. When they were on their buffalo hunts and found goldenrods blooming, they knew their corn was ripening back home.

Gooseberry, Wild

The berries were used as a fruit in season. It was also used as a game by Indian children. Children chose sides and the side that could eat the most berries without making a grimace would win.

Grape, Wild
The fruit was used for food, either fresh or dried for winter use. Sometimes large grape vines were tapped and sap collected from them. Sap tasted like grape juice.

Grass, Porcupine
The stiff awns of this grass were firmly bound in a bundle, from which the pointed grains were burned off, leaving a brush used for dressing the hair.

Grass, Switch
After the buffalo hunt, the Indians were careful not to lay the meat on this grass because the glumes of the spiklets would stick to the meat and would stick in the throat of anyone eating it.

Gum Plant
Compass Plant; the Indian children gathered chewing gum from the upper parts of the stem. Indians believed this plant attracted lightning and so never made camp where this plant abounded.

Hackberry
The berries were pounded into a fine powder and used as a flavor for meat.

Horsetail, Scouring Rush, Snakegrass, Joint Rush
This was used for polishing as we use sandpaper. Indian children sometimes made whistles from the stems.

Indian Cup Plant
The root stock of this plant was commonly used in the smoke treatment for cold in the head, neuralgia and rheumatism. It was also used in the vapor bath.

Indigo, False
Water String; whenever possible this was gathered and spread on the ground to keep meat clean after the shooting of Buffalo.

Jack in the Pulpit
This plant was pulverized and used in treating headaches by dusting on the top of the head and on the temples. The fruit resembles an ear of corn. The dust was also used for rheumatism.

June Berry, Saskaton
The berries were eaten for food. The stems were used for arrow shafts.

Lambs Quarter
This plant was used, cooked for greens. It was also used to paint bows and arrows green.

Lead Plant
Shoestring; the stems were used in cases of neuralgia and rheumatism. The small stems broken in short pieces were attached to the skin by moistening one end with the tongue. Then they were fired and allowed to burn down to the skin. The leaves were sometimes used to make a drink like tea and sometimes for smoking material.

Licorice, Wild

The root was chewed for a toothache. The leaves after being steeped were applied to the ears for earache. A poultice for sore backs of horses was made by chewing the leaves.

Meadow Rue

The fruits in August were broken off and stored away for their pleasant odor. The scent is very delicate and was scattered over the clothing. Sometimes this plant was used as a stimulant for horses, being stuffed into the horse's nostrils during forced marches of three or four days.

Nettle

The dried stocks were crumpled or pounded to free the fiber from the woody part. This fiber was used in making twine and cord. Sometimes the fiber was woven into cloth.

Oak, Bur

Acorns of this tree were used for food. The bitter properties were taken out by leaching with wood ashes from basswood. The bark of the root was scraped off and boiled and used as a medicine for bowel trouble.

Onion, Wild

All species of this plant were used for food, commonly raw and fresh as a relish, sometimes cooked as a flavor for meat and soup. It was also eaten fried.

Parsnip, Cow

Beaver Root; the tops of this plant were used in the smoke treatment for fainting and convulsions. The root, scraped and boiled, was applied as a poultice for boils.

Plantain

A bunch of these leaves was heated and applied to the foot to draw out a thorn or splinter.

Plum, Wild

The plums were a delicacy, eaten raw, boiled into sauce, or dried for winter use. The bark of the roots, after being scraped and boiled, was applied as a remedy for cuts of the skin.

Prickly Pear

The fruits were eaten fresh and raw after the spines were removed or they were stewed. They were also dried for winter use. The sticky juice of the stems was used as a sizing to fix the colors painted on hides.

Rag Weed

The leaves were placed on the abdomen for treating nausea.

Raspberry, Wild

The berries were used for food either fresh or dried. The young leaves were steeped to make a drink like tea.

Rattle Pod, Black

This was used by small Indian boys as a rattle when they played at having a dance.

Rose, Wild
The inner bark was sometimes used for smoking, either alone or mixed with tobacco.

Sage, Wild
A decoction of this plant was used for bathing. Any person who had broken some taboo had to bathe with this sage liquid.

Sorrel, Sheep
Yellow Wood Sorrel: a plant with leaves that have a taste "sour like salt." The buffalo was fond of this plant. Children ate the leaves and flowers. The bulbs were pounded and fed to horses to make them fleet.

Sour Dock
The green leaves were crushed and bound tightly on boils to draw out the suppuration. It was also eaten by some tribes for greens.

Spiderwort
When a Dakota Sioux male was in love, and while walking along saw this flower, he sang a song to it which personified the qualities of his sweetheart as they are called to mind by this beautiful flower.

Sumac, Smooth
Water Fruit Bush: in the fall when the leaves turned red they were gathered and dried for smoking. Fruits when ripe were used for a beverage similar to lemonade.

Sunflower
The Indians extracted an oil from the seeds by boiling. This was used like we use hair oil.

Tipsin
Indian turnip: The roots of this plant were an important item in the vegetable diet of the plains tribes. They were eaten fresh, uncooked or cooked. They were dug in June or July to be peeled and dried for winter use.

Willow, Sandbar
The stems of this willow were peeled and used in basket making.

Willow Tree
Willows of various species were used for different things. The poles of willows were used to construct the frames of earth lodges.

Yarrow, Western
An infusion of this herb was used to bathe swellings. A wad of the leaves was put into the ear for earache.

State Flowers and Trees

This listing of state flowers and trees can be used to initiate student research about the plants, or as a basis from which a bulletin board of state flowers and trees can be constructed.

STATE	FLOWER	TREE
Alabama	Camellia	Southern (Longleaf) Pine
Alaska	Forget-me-not	Sitka Spruce
Arizona	Saguaro	Paloverde
Arkansas	Apple blossom	Pine
California	Golden Poppy	Redwood
Colorado	Columbine	Colorado Blue Spruce
Connecticut	Mountain Laurel	White Oak
Delaware	Peach Blossom	American Holly
Florida	Orange Blossom	Sabal Palm
Georgia	Cherokee Rose	Live Oak
Hawaii	Hibiscus	KuKui (Candlenut)
Idaho	Mock Orange	Western White Pine
Illinois	Violet	Bur Oak
Indiana	Peony	Tulip (Yellow Poplar)
Iowa	Wild Rose	Oak
Kansas	Sunflower	Cottonwood
Kentucky	Goldenrod	Tulip tree
Louisiana	Magnolia	Bald Cypress
Maine	Pine cone and Tassel	Eastern White Pine
Maryland	Black-Eyed Susan	White Oak
Massachusetts	Trailing Arbutus	American Elm
Michigan	Apple Blossom	White Pine
Minnesota	Showy Lady's-Slipper	Red (Norway) Pine

STATE	FLOWER	TREE
Mississippi	Magnolia	Magnolia
Missouri	Hawthorn	Dogwood
Montana	Bitterroot	Ponderosa Pine
Nebraska	Goldenrod	American Elm
Nevada	Sagebrush	Single-leaf Pinon
New Hampshire	Purple Lilac	Paper (White) Birch
New Jersey	Violet	Red Oak
New Mexico	Yucca	Pinon (Nut Pine)
New York	Rose	Sugar Maple
North Carolina	Dogwood	Pine
North Dakota	Wild Rose	American Elm
Ohio	Scarlet Carnation	Ohio Buckeye
Oklahoma	Mistletoe	Redbud
Oregon	Oregon Grape	Douglas Fir
Pennsylvania	Mountain Laurel	Eastern Hemlock
Rhode Island	Violet	Red Maple
South Carolina	Yellow Jessamine	Palmetto
South Dakota	Pasqueflower	Black Hills Spruce
Tennessee	Iris	Tulip Poplar
Texas	Bluebonnet	Pecan
Utah	Sego Lily	Blue Spruce
Vermont	Red Clover	Sugar Maple
Virginia	Dogwood	Flowering Dogwood
Washington	Rhododendron	Western Hemlock
West Virginia	Big Laurel	Sugar Maple
Wisconsin	Violet	Sugar Maple
Wyoming	Indian Paintbrush	Plains Cottonwood (Balsam Poplar)

ARTICLES OF SPECIAL INTEREST

1. Timberline Ancients Are Rewriting History
   By Darwin Lambert
   National Wildlife, Dec.-Jan., 1973, pages 44-47

   A very interesting article about the Ancient bristlecone pine trees. Some of the trees are nearly 5,000 years old. Their rings are being studied to learn more about our past history. The article includes pictures and a map showing where the bristlecone pines are living in the United States today.

2. The Sweetest Meat Grows on Trees
   By Ned Smith
   National Wildlife, Oct.-Nov., 1972, pages 21-25

   An article about the edible nut-bearing trees of the United States. The various trees, their nuts, collecting methods, storing, and using the nuts are discussed. Some of the trees included are walnut, chestnut, pecan, butternut, hazelnut, beechnut, and hickory nut.

3. Tree Top High Rise
   By Barbara J. Porterfield
   Ranger Rick, Oct., 1971, pages 39-43

   A pictoral and narrative look at the types of animal life associated with various levels or layers along a big old tree from top to bottom.

4. Trees With Knees
   By Fay Venable
   Ranger Rick, July, 1972, pages 20-22

   A discussion and pictures of the bald cypress trees that grow in the southern swamps. Gives some explanations of how the tree possibly uses its knees.

5. Where The Rivers Meet The Sea
   By John Berrill
   Ranger Rick's, Nov., 1971, pages 25-32

   A discussion about the habitats created by the estuaries formed where rivers empty into oceans. Several of the ways animals use the areas for nesting and feeding are described. The article ends by pointing out how man's activities are destroying the estuaries and thus ruining one of our valuable food sources.

6. Grass - Conserves Soil and Water
   By Eleanor Heady
   Ranger Rick's. Oct., 1971, pages 44-47

   The problem that were encountered in changing native grasslands into farmland are discussed. Methods of correcting the problems are illustrated and described.

7. The Chaparral
By Mary Carey
Ranger Rick's, Dec., 1971, pages 18-23

The plant and animal life of the chaparral and their struggle for survival is presented.

8. Friend of the Forest
By Gerry Bishop
Ranger Rick's, March, 1972, pages 16-25

A story about the work of John Mur, to protect our forest and his love for the forest.

9. The Seafaring Coconut
By D. A. Hoover
Ranger Rick's, Aug.-Sept., 1972, pages 24-29

A description of how coconuts are used by man and how the coconut seed can be spread by the oceans.

10. Invite Wildlife to Your Backyard
By Jack Thomas and Others
National Wildlife, Vol. II #3, April-May, 1973, pages 5-16

Step by step directions on how to use various plants to change a plain backyard into an enjoyable wildlife habitat, are given and illustrated.

11. Kansas Forest and Wood Related Industries
Kansas Magazine, 3rd Issue of 1971
Published by Kansas Economic Development Commission

This complete issue is devoted to various aspects of forestry in Kansas and the industries that depend on Kansas forest products.

12. Flowers That Kill to Eat
By Michael Godfrey
National Wildlife, Vol. 10, #5, pages 10-13

The insect eating plants found in Southern United States are illustrated through excellent photographs. Their habitat and insect capturing methods are very well described.

13. Forest Plants That Tell a Story
By Howard A. Miller
American Forest, Nov., 1973, pages 32-33

A brief story of how plants growing in an area give you information about the soil, historical use, and other factors that influence the area.

14. A Leaky Green Umbrella
By James E. Coufal
Ranger Rick's, April, 1972, pages 10-13

A very interesting story about how trees help control the circulation of water on the Planet Earth.

Plant Adaptations - Lawn Grasses*

Grass	Soil Preference	Time to Plant	Withstands Shade	Main Regions	Comments
Kentucky Bluegrass	Neutral soil	Fall	No	Found in all states; major grass in Northeast and Midwest	Popular turfgrass, frequently mixed with red or Chewings fescue for shady areas
Merion Kentucky Bluegrass	Neutral soil	Fall	No	Same as above	Low growing, highly resistant to leaf spot, usually more heat- and drought-resistant than common Kentucky bluegrass
Red Fescue	Moderate to good drainage; can stand acid soil	Fall	Yes	Cool, humid regions	Frequently mixed with Kentucky bluegrasses; Pennlawn variety popular
Creeping Bentgrass	Thrives on relatively poor, wet soils	Fall	Partially	Newfoundland to Maryland, British Columbia to northern California	Tolerates low temperature; variety Pennoross more disease-resistant
Velvet Bentgrass	Well-drained and aerated soils	Fall	Partially	Cool, humid Northeast, milder sections of Pacific NW	Good turf quality; variety Kingstown vigorous grower with high resistance to dollar spot
Bermudagrass	Wide variety of fertile, well-drained soils	Spring	No	Most of Eastern half of U. S. west to Kans., Okla., Tex.; parts of New England, Ohio, Ind., Ill.	Drought-tolerant in humid regions; needs extra water in arid areas
Carpetgrass	Sandy or sandy-loam soils where water is near surface	Spring	Moderately	N. Carolina to Florida, Costal Plains west to Texas	Not drought-resistant
Buffalograss	High clay content; does poorly in sandy soils; can stand alkaline soils	Spring	Partially	Central and southern Great Plains	Drought-resistant
Annual ryegrass	Fertile	Fall best spring	No	Cool, moist regions	Planted as temporary cover until slower-growing grasses are established dies in winter in northern states; in South, seeded over bermudagrass

*Changing Times, September 1971, Page 47.

APPENDIX F

Field Trip Related Material

Sample Request to Principal for Field Trip. F-2
(Form available from your building principal)

Field Trip Guidelines for Principal F-3

Sample Letters to the Students' Parents

(Choose only one; contact your principal to determine which form to use.)

A. Not requiring parent signature. F-4

B. Requiring parent signature. F-5

Field Trip Leader Directions. F-6

Plant Observation Data Sheet. F-10

Field Trip Discussion Guide F-11

THE TOPEKA PUBLIC SCHOOLS
REQUEST TO PRINCIPAL FOR FIELD TRIP

Elementary Schools

Date Submitted _____

Any classroom teacher who plans to take a group of students on a field trip should discuss the details of the trip with the principal of the school in advance of the date for the trip. In most cases, this planning with the principal should be done two weeks in advance of the trip. This form should be properly completed in duplicate and signed by the teacher and the principal. One copy is filed in the office of the principal and the duplicate is sent to the Office of Instruction to be filed there.

School_____ Grade_____ Number of Pupils_____

Date of Trip_____ Leave_____ Return_____

Description of Trip The field trip will utilize the City of Topeka Conservatory located in the southwest corner of Gage Park. Leadership will be provided by EE Project staff and volunteers trained by the project staff. The students will be involved in activities developed by the Environmental Education Project.

Objectives of Trip

(1) To carefully observe and collect data about different groups of plants.

(2) To relate plant adaptations to various habitats.

(3) To explore the ways man utilizes plants.

(4) To observe and develop an understanding of how a greenhouse is operated.

Means of Transportation _____

Required Cost Per Student_____

Teacher's Signature_____

I approve the above request and accept responsibility for the field trip as stated in the guidelines on the reverse side.

Principal's Signature_____ Date_____

FIELD TRIP GUIDELINES FOR PRINCIPALS

1. Have definite educational objectives and procedures for evaluation been established?
2. Is the field trip appropriate for the age level and/or subject area? And can it meet established objectives?
3. Are the educational outcomes commensurate with the time taken from the regular instructional program?
4. Have the students been adequately prepared to make the field trip a worthwhile experience?
5. Has the teacher made adequate arrangements at the field trip site? (Dates, time schedule, guides, safety measures, proper dress, etc.?)
6. Have any of the students within the teacher's group been denied the opportunity to participate? If so, was good judgment used in making the decision?
7. Have arrangements been made for those students who are not participating?
8. Are you aware of the length of time the students will be away from your building?
9. Does the field trip conflict with other scheduled school activities?
10. Have arrangements been made for students to be absent from other classes and to do madeup work?
11. Are substitute teachers needed?
12. Have parents been notified of the field trip and been given an oppotrunity to notify the school and ask that their child be excused from the trip?
13. Do you have on file a parent-signed pupil information record for each child giving permission for field trips (Item 164)? (Principals may wish to require signed parental permission slips for specific individual trips.)
14. Are the transportaiton arrangements adequate and safe? Are the vehicles adequately insured? (Remember that student drivers are not permitted to transport other students.)
15. Is each student required to pay a fee? If so, do you know the total charge and what expenses it covers?
16. Have you made arrangements for those students who state they cannot "afford" the field trip fee?
17. Have arrangements been made for emergency situations?
18. Has the field trip form been completed in detail and filed with the designated offices?
19. Does this field trip conflict with Topeka Plan Policy No. 11220 (1) which prohibits "the giving or attending of paid performances during the school day for which tickets will be sold or admission charged to students"? (This includes commercial movie and theatrical productions.)
20. If you have doubts concerning this trip, have you discussed them with the departmental supervisor or office of instruction?
21. Are you, as principal, "ready and willing" to accept your official responsibility for this field trip?

The Topeka Public and Parochial Schools
Unified School District No. 501
Environmental Education Demonstration Project
Phone: 232-9374

Dear Parent:

Your child's class will be taking a field trip to the Topeka Conservatory located in the southwest corner of Cage Park on _____

Students will leave the school at _____and return by_____ They will need to wear clothing that will allow them to be comfortable inside the conservatory. On warm days the conservatory can be very humid inside.

The class has been studying about plant habitats, adaptations, uses and how plants are affected by man. During the field trip students will be collecting data about different plant groups, plant adaptations, man's utilization of plants and how a greenhouse is operated.

The field trip will be conducted by Environmental Education project staff or other people trained by the project staff. Following the field trip students will continue their study of the role of plants in our environment.

You are invited to participate in this field trip as an observer. If you wish to go on the trip or have any questions, please contact me.

If you do not want your child to participate in this field trip, please contact our building principal, and your child will do alternate activities in the school.

The Topeka Public and Parochial Schools
Unified School District No. 501
Environmental Education Demonstration Project
Phone 232-9374

Dear Parent:

Your child's class will be taking a field trip to the Topeka Conservatory located in the southwest corner of Gage Park on _____

Students will leave the school at _____and return by_____ . They will need to wear clothing that will allow them to be comfortable inside the conservatory. On warm days the conservatory can be very humid inside.

The class has been studying about plant habitats, adaptations, uses and how plants are affected by man. During the field trip students will be collecting data about different plant groups, plant adaptations, man's utilization of plants, and how a greenhouse is operated.

The field trip will be conducted by Environmental Education project staff or other people trained by the project staff. Following the field trip students will continue their study of the role of plants in our envrionment.

You are invited to participate in this field trip as an observer. If you wish to go on the trip or have any questions, please contact me.

Students will not be allowed to participate in this field trip unless this form is returned with your signature.

I give my permission for_____to participate in the field trip to the Conservatory.

_____
Parent's Signature

Field Trip Leader Directions

The major responsibility of the group leader is to assist students in viewing and understanding plant adaptations, interactions, interrelationships, uses and values.

Each student will have a data sheet that is to be completed during the field trip. The data sheets can be completed by the group working together. The data sheets are intended to help direct students' observations and provide concrete material from which the classroom teacher can conduct a post field trip discussion. Hopefully each group will use different plants for their examples in completing the data sheets so a larger variety of data will be available to draw from in the follow-up classroom discussion. Do not limit your activities to just those necessary to complete the data sheet.

It is important that the leaders make sure that all students in their group are able to see the plants being observed. Use questions to direct student observation and attention. Avoid excessive lecturing. As students ask questions do not hesitate to admit you do not know the answer. Sometimes by asking questions and directing more careful observation the students can answer their own questions.

The following are possible examples of data collection that can be used by the group leader. No leader is expected to use each of these examples, or limit their groups' observation to only these. Use these facts only as a basis for guiding student observations.

First Room (Tropic)

1) Spanish moss - air plant, needs high humidity, obtains minerals and moisture from air, not a parasite, has flowers, formerly used for packaging and in stuffing furniture, damages fences and trees in southern states.

2) Banana tree - soft stem, leaves develop from outside stem, large cells that can be easily seen, tree dies after producing fruits, new trees from shoots, harvested by cutting tree down, fruit develops in hands, large flower at end of fruit stock is male, bananas normally do not contain fertile seeds.

3) Ferns - moist areas, fiddleheads, unrolling of leaves, spores as reproductive structure, source of our coal supply.

4) Swiss Cheese Plant - natural holes in leaves, cob-like part of fruit is edible, kernels are poisonous, a member of the philodendron group.

5) Common Fig tree - notice lobed leaves, produces edible fruit, fig newtons, two crops per year, looses leaves after fruiting, this is the type of fig leaves Adam and Eve used.

6) Fiddle leaf fig - used as foliage plant, very tolerant plant, fruit not edible, compare with common fig.

7) Hong Kong Orchid tree - also called butterfly tree, notice leaf.

8) Man Eating Plant - stories originated from movie people, mans' bones under plant resulted from war.

9) Pencil plant - relative of poinsettia, sap is toxic, causes rash.

10) Washington Palm - windmill palm, thorns on leaf stem, honor George Washington, cannot trim palms without killing.

11) King Palm - note how leaves drop.

12) Rubber tree - source of latex.

13) Coffee tree - source of commercial coffee, needs hot moist climate, needs around 75 inches rainfall, humusy soil, beans inside pod.

14) Oleander - sap is poisonous, leaves in threes, semitropic, branches used as weiney sticks causes death.

15) Gumbo-limbo tree - native to tropic areas, very soft wood, decays too fast to be useful, very light wood.

16) Mahogany - among most useful woods, widely used in furniture, top must be cut to prevent from damaging roof, contrast with gumbo-limbo.

17) Bougoinvillea - live in tropic and semitropic, pink is not flowers but leaves or bracts, often used to cover houses as decoration, typical in South Florida, very handy color for insect attraction.

West Room

1) Dumb cane - widely used for indoor decoration, contains oxalic acid crystals that cause extreme pain and paralysis to jaw and face muscles.

2) Orchids - air plant, not parasite, roots must not be in soil, epiphyte, roots turn greenish when full of water, somewhat hard to raise, great variety.

3) Texas Longhorn - of ocasha tree family, thorns look like longhorns, adapted for semi-arid habitat.

4) Water hyacinth - the hyacinth is a real problem in the south, introduced plant, the manatee was introduced to control the hyacinth.

5) Water fern - an aquatic fern.

6) Sensitive plant - responds to touch, a legume, several found in Kansas.

7) Point out grafting on orange tree.

8) Discuss purpose of cutting bed.

9) Point out carnivorous plant display, plants adapted to eat insects.

North Room

1) Bedding plants for city park flower beds - 30 to 40 thousand per year.

2) Monkey puzzle - note sharp points on leaves, tree grows over leaves.

3) Ginger - spread by rhizomes, all parts can be used, have students smell.

4) Norfolk Island Pine - Can stand low light intensity, low humidity, can be used as house plant, near equator it grows to 200 feet tall, used for lumber in New Zealand Islands.

5) Hibiscus - Use to show flower structure.

South Room (Cactus and Succulents)

1) Point out difference in cactus and succulents, thorns around each air hole on cactus

2) Point out the cactus thorns are modified leaves, provide protection, reduce loss of water.

3) Point out role of cactus in soil conservation.

4) Point out reproduction by budding.

5) Old man cactus - hairy-like covering protects cactus from sun.

6) Jumping cactus - thorns slant backward, each piece can grow into a new plant.

7) Soquaro - Birds can nest in the cactus without damaging it, plant dies if man cuts on it. Can grow to 50-55 feet high, swells to store water.

8) Barrel cactus - liquid can be squeezed from soft tissue in cactus center, hooked thorns can be used as fish hooks.

9) Prickly Pear - pealed and used for food.

10) Prehistoric cactus - still have leaves, discuss evolution of cactus.

11) Christmas Cactus - grew well in wood stove-heated homes which have cool nights and warm days.

12) Parachute plant - special insect needed to pollinate.

13) Medicine plant - juice used to treat burns.

14) Elkhorn cactus - horticulture deformative, could be a genetic change that causes mutations, relative of poinsettia.

15) Yucca - found in southwest United States, called soapweed, roots used as hair shampoo, source of needle and thread.

16) Century plants - use fibers as threads, pointed stems used as needles, dies once it blooms, may live 100 years more or less, tequila is made from plant juice, important in soil conservation.

General Conservatory Comments

1) Point out different examples of ways plant reproduces, budding, grafting, seeds, cuttings, spores, vegatative, shoots, air rooting.

2) General plant groups: woody, non-woody, ferns, flowering, mosses, tripic, desert, house plants, herbaceous, etc.

3) Variation and similarities in leaves, flowers, and plants in general.

4) Basic needs of green plants.

5) Adaptations.

6) Economic use of plants.

7) General operation of conservatory.

8) Use of conservatory plants.

9) Source of conservatory plants

Outside

If time and weather permit spend a few minutes outside viewing plants.

1) Visit pine trees either east or south of conservatory, notice pine leaves on ground; they increase acid in soil.

2) Compare evergreens and deciduous.

3) View other plants as available.

Plant Observation Data Sheet

Student Name_____

	Plant Observed	Plant Observed
Plant Name		
Leaf Size		
Sketch Leaf showing veins, shape, and margin		
Sketch general plant shape		
Special Adaptation		
Native Habitat		
Plant group		
Other Comments		

From the plants you observed name a plant that fits in each of the following groups:

Tropics_____ Water_____ Grasses_____ Mountainous_____

Deserts_____ Conifer_____ Poisonous_____ Swampy_____

List four different ways that can be used to produce new plants:

_____ _____ _____ _____

Name two plants that are used for food: _____ _____

Name two plants that are economically important other than for food:

_____ _____

Name two uses of the plants growing in the conservatory: _____ _____

Describe four different plant adaptations observed and how they help the plants:
(Use the back of this page for your answer.)

Field Trip Discussion Guide

The following comments and questions will help guide a classroom discussion following the conservatory field trip. Every attempt possible should be made to encourage the students to infer based on their observations.

Basic Needs of Plants - All students should realize that all green plants need light, water, carbon dioxide, and minerals in order to grow. How plants obtain these basic needs varies with the habitat in which the plant lives.

Methods of plant reproduction - Plants have a variety of natural reproduction methods: seeds, budding, shoots, spores.

Man has increased plant quality through cuttings, grafting and air rooting.

The advantage of using air rooting and cuttings is that the new plants are just like the parent plant.

Grafting allows the strongest root and most desirable top to be put together.

Adaptations - Allow the students to discuss examples of adaptations for reproduction, protection, fitting the habitat, and others.

Characteristics of plant groups - Have the students describe one observed characteristic of each group: cactus,succulents, ferns, mosses, water plants, tropic plants, desert plants, orchids, conifers, and deciduous.

Plant structure - Students should be able to describe variations in leaves, stems, roots, and flowers of the various groups of plants.

Economic plants - Students should be able to name ten plants observed and how we use them.

Operation of the Conservatory - Discuss how light, heat, humidity, water, disease, and other factors are controlled in the Conservatory.

Sample questions:

Why does the city operate a conservatory?

Where do the plants come from that are found in the conservatory?

Why do bananas not have seeds?

How do we get new banana trees?

What is different about the banana tree trunks?

What type of climate does a banana tree need?

How does a cactus differ from a succulent?

What uses has man made of cactus and succulent plants?

What is the natural purpose or role of desert plants?

How do ferns reproduce?

Are ferns as common today as they were in the past?

What is a fiddlehead on a fern plant?

How do orchids differ from other plants?

Why are some flowers very colorful while others are not?

Why is the underside of most leaves lighter in color than the upper surface?

What advantage is it to use cuttings and grafting as a method to produce new plants?

How are the plants growing in the conservatory used?

Which plants in the conservatory are used for food?

How are some of the other plants in the conservatory used by man?

Why is it important for managers of greenhouses to know the natural habitat of each plant?

How does the tropic plant differ from the desert plant?

Should the city spend money to operate a conservatory like this one?

Would you like to take your parents to visit the conservatory?

Which groups of plants are not represented in the conservatory?

APPENDIX G

Poems

The sample poems about plants included in this appendix can be used in a variety of ways. Students can 1) interpret the author's reason for composing the poems, 2) illustrate the poems, 3) present the poems to the class through reading and acting, 4) use these as examples from which to gain ideas about which they can compose poems, and 5) use the poems as a means by which they can view the world through another's senses.

Teachers should refer to Topic VI for additional suggestions utilizing these poems. Other poems about plants can be used with equal or better success.

Source of the Poems:

Hale, Jeanne, Editor-in-Chief, Wide, Wonderful World. Grolier, Inc., New York, 1958.

Hale, Jeanne, Editor-in-Chief, Man and His World. Grolier, Inc., New York, 1958.

Hale, Jeanne, Editor-in-Chief, Children Everywhere. Grolier, Inc., New York, 1958.

Johnson, Edna and Others, Anthology of Children's Literature. Houghton Mifflin, Boston, 1959.

Ranger Rick's Nature Magazine, published by National Wildlife Federation, Washington, D.C.

The Green Grass Growing All Around G-2

Early Autumn G-2

Yucca. G-2

Trees. G-3

The Willow Cats. G-3

Smells G-3

Spring Families. G-3

The Wind and The Leaves. G-4

Tree Talk. G-4

Plum Blossoms. G-4

THE GREEN GRASS GROWING ALL AROUND*

Old Rhyme

There was tree stood in the ground,
The prettiest tree you ever did see;
The tree in the wood, and the wood in the ground,
And the green grass growing all around.
And the green grass growing all around.

And on this tree there was a limb,
The prettiest limb you ever did see;
The limb on the tree, and the tree in the wood,
The tree in the wood, and the wood in the ground,
And the green grass growing all around.
And the green grass growing all around.

And on this limb there was a bough,
The prettiest bough you ever did see;
The bough on the limb, and the limb on the tree,
The limb on the tree, and the tree in the wood,
The tree in the wood, and the wood in the ground,
And the green grass growing all around.
And the green grass growing all around.

Now on this bough there was a nest,
The prettiest nest you ever did see;
The nest on the bough, and the bough on the limb,
The bough on the limb, and the limb on the tree,
The limb on the tree, and the tree in the wood,
The tree in the wood, and the wood in the ground,
And the green grass growing all around.
And the green grass growing all around.

And in the nest there were some eggs,
The prettiest eggs you ever did see;
Eggs in the nest, and the nest on the bough,
The nest on the bough, and the bough on the limb,
The bough on the limb, and the limb on the tree,
The limb on the tree, and the tree in the wood,
The tree in the wood, and the wood in the ground,
And the green grass growing all around.
And the green grass growing all around.

*Man and His World, Pages 78 -79

EARLY AUTUMN*

by Ann King

"Pop!" went the milkweed pod,
"Pop!" and "Puff!"
"My seeds have been sheltered
Long enough."

Just then a summer breeze
Stirred the air.
"Hello, seeds, let me take
You somewhere."

So every milkweed seed,
Brown and cute,
Floated away on its
Parachute.

*Wide, Wonderful World, Page 73

YUCCA*

by Ann Nolan Clark

Yucca
Growing
So tall,
Like candles;
So white,
Like candles;
With a flower
For light.

We twist your little leaves
Into strings of thread;
We knot your strong stems
Into rope.
We weave your fibers
Into mats and baskets;
We pound your roots
For soap to make us clean.

Yucca,
Tall, white Yucca,
You make may heart sing
With your beauty.

*Anthology of Children's Literature, Page 1018

TREES*

by Harry Behn

Trees are the kindest things I know,
They do no harm; they simply grow

And spread a shade for sleepy cows,
And gather birds among their boughs.

They give us fruit in leaves above,
And wood to make our houses of,

And leaves to burn on Hallowe'en,
And in the Spring new buds of green.

They are the first when day's begun
To touch the beams of morning sun,

They are the last to hold the light
When evening changes into night,

And when a moon floats on the sky
They hum a drowsy lullaby

Of sleepy children long ago ...
Trees are the kindest things I know.

*Wide, Wonderful World, Page 8.

THE WILLOW CATS*

by Margaret Widdemer

They call them pussy-willows,
   But there's no cat to see
Except the little furry toes
   That stick out on the tree.

I think that very long ago,
   When I was just born new,
There must have been whole pussy-cats
   Where just the toes stick through--

And every Spring it worries me,
   I cannot ever find
Those willow-cats that ran away
   And left their toes behind!

*Wide, Wonderful World, Page 73

SMELLS*

by Kathryn Worth

Through all the frozen winter
My nose has grown most lonely
For lovely, lovely, colored smells
That come in Springtime only;

The purple smell of lilacs,
The yellow smell that blows
Across the air of meadows
Where bright forsythia grows;

The tall pink smell of peach trees,
The low white smell of clover,
And everywhere the great green smell
Of grass the whole world over.

*Wide, Wonderful World, Page 71.

SPRING FAMILIES*

by Frances Frost

March shakes the pussy willows out
Of their brown wintry beds,
And gets the first grass-children up
And combs their tousled heads.

April mixes silver rain
And golden sun to suds
To wash the scarlet petticoats
Of the little maple buds.

And May sews round bright dandelion
Buttons on the hills,
And ties their yellow bonnets on
The youngest daffodils.

*Wide, Wonderful World, Page 45.